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TECHNICAL REPORT

SEASONAL OCEANOGRAPHIC STUDIES IN McMURDO SOUND, ANTARCTICA

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ABSTRACT

During the austral winter of 1960-1961, a series of oceanographic stations was taken at an icehole 3 miles offshore in McMurdo Sound, Antarctica. The icehole was covered by an insulated hut which provided a warm field laboratory for oceanographic observations. A gasoline powered generator supplied current for the operation.

The hut was visited whenever weather permitted and routine observations were conducted at intervals of about two weeks. Sea water temperature, salinity, dissolved oxygen, and subsurface currents were measured, and bottom sediments and marine life were noted.

Oceanographic samples and current measurements were made at 18 different depths from the surface to the bottom (580 meters). Oceanographic factors were very constant during the winter but by early summer micro changes in the upper waters became apparent. Temperatures rose, dissolved oxygen increased markedly, and salinity decreased; however, little change occurred in the deeper water. Currents averaged about one-half knot of drift and apparently were of tidal origin. The maximum observed current drift occurred at 500 meters and amounted to 1.83 knots.

Systematic sampling of the bottom was carried out with a Peterson grab sampler and by the use of bottom tangles and fish traps. The bottom was found to harbor a rich and wide variety of invertebrate forms. At least five species of fish were captured.

FOREWORD

The Shore Based Seasonal Oceanographic Studies at the McMurdo Sound icehole during 1960-1961 provide valuable information on environmental conditions under Antarctic ice. The oceanographic data presented in this report were collected in support of Antarctic research through the joint support of the National Science Foundation and the U. S. Navy.

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Hydrographer

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I. INTRODUCTION

A. Historical

Since the days of Captain Cook's Antarctic voyage (1772-1775), soundings, water temperatures, salinities, and other oceanographic elements have been an important part of cruises to the southern continent. At the present time a mass of oceanographic data exists, much of which has been correlated with the corresponding features of adjacent waters, so that the physical, chemical, and biological characteristics of the Antarctic seas are now fairly well known, at least as far south as the Antarctic Convergence or to the northern edge of the pack ice. Of the waters adjacent to the coast, especially the inshore portions, considerably less is known and it has been only comparatively recently that work has been attempted in this area.

When Sir James Clark Ross sighted and later named McMurdo Sound in 1841, he was unable to penetrate the Sound because of fast ice. Ross's men, notably Joseph Hooker, however, made many oceanographic observations in the Ross Sea and other parts of the Antarctic. Seasonal studies in the Antarctic were first carried out by Arctowski and his assistants on board the BELGICA during the winter of 1898 when this ship was beset in the ice in the region north of the Bellingshausen Sea, an area which surprisingly enough remains one of the least known oceanographically of Antarctic waters. Some seasonal oceanographic studies have been made at most of the Antarctic bases since then, notably by the Gauss Expedition in 1902 and 1903, the Australians and French, and more recently by the Russians. The earlier studies were sporadic in nature and were carried out under very adverse conditions, the work being done in open iceholes for the most part.

Such was the nature of Captain Scott's inshore oceanographic work on both the DISCOVERY expedition and on his last expedition. Fish traps and nets were lowered through holes in the ice which had to be constantly dug out and kept open and emphasis was placed upon the biological more than on the physical and chemical side of oceanography. Canvas shelters or windscreens were erected but work carried out under such conditions, especially during the dark winter night, must have been very trying to say the least. Shackleton in his 1907 expedition, which wintered in McMurdo Sound at Cape Royds, also carried on similar work; both Scott and Shackleton, in addition, made tidal studies.

In 1955, the U. S. Navy commenced sending icebreakers to McMurdo Sound as part of Operation DEEP FREEZE, and this has continued to the present time. Oceanographers from the Hydrographic Office have made a considerable number of oceanographic observations from isolated stations within McMurdo Sound, however, the tendency at present is to concentrate on specific problems, such as the ice potential prediction oceanographic stations which were commenced on DEEP FREEZE 61.

The first serious attempt to make regular, seasonal oceanographic observations in inshore antarctic waters was the work of J. S. Bunt of the Australian National Antarctic Research Expeditions; in 1956 and 1957, he carried out an extensive program of physical, chemical, and biological observations in the waters adjacent to the Australian base at Mawson. Two stations were occupied, one in 25 to 30 meters of water and the other in over 100 meters. Over a period of eight months, regular samples were taken at different depths throughout the water column. Plankton studies were carried out simultaneously. (Bunt, 1960).

B. Ice Conditions

During March of 1959, the fast ice in McMurdo Sound broke out farther south than any other time in the recorded history of the area, which is only about 60 years. The far southern edge, which had also broken away some of the shelf ice, was over 2 miles south of Cape Armitage. New ice formed over the water area and, on this ice, Van der Hoven and Stewart, who were at the time carrying out other geophysical work at Scott Base, erected a small hut over an icehole. This hut was lost a month or so later when the new ice again broke out, but in May a second hole was covered by a hut and observations for temperature, salinity, and currents were made at intervals until August of that same year.

C. Establishing the Icehole Station

The present writers arrived at NAF McMurdo (Plates I & II) in December 1959 at a time when the fast ice still extended as far north

PLATE I. NAF MCMURDO VIEWED FROM OBSERVATION HILL.

PLATE II. STANFORD UNIVERSITY BIOLOGICAL LABORATORY, NAF MCMURDO.

as Cape Royds. The uncertainty of another ice break-out such as that which destroyed Dr. Van der Hoven's hut the previous year postponed establishment of an oceanographic station until well into March. By that time, the fast ice had not broken out farther south than Arrival Bay to the north of Hut Point. In the meantime, an electric-hydraulic winch and "A" frame with a $2\frac{1}{2}$ KW Onan generator were installed on a heavy sled, which was towed with a Polecat snow vehicle. (Plates III & IV). Two series of sounding lines were run north and south and roughly east and west across the new ice, which was at that time between 5 and 9 feet thick. (Plates V & VI). An eight-inch hole was drilled with a Jiffy power drill which worked very well at thicknesses less than about 10 feet; at greater thicknesses considerable trouble was experienced with the auger sticking in the hole. This trouble probably was caused by the slight buckling of the four three-foot auger sections at greater depths. The use of arctic diesel oil in the hole might have prevented some sticking and freezing, but this was not tried. Attempts were made to drill larger holes with a Remington one-foot diameter ordinary earth auger and motor. After the cutting edge of the auger had been changed to about 25° from the vertical, the drill cut very rapidly down as far as about 4 feet. Beyond this depth, however, the extensions buckled and caused the auger to stick and freeze in. Moreover, spiral flanges for removing chipped ice were fitted only on the first three feet of the auger which necessitated removing and clearing the auger frequently, a job which tested the strength of two men.

A sounding lead, consisting of a three-foot Phleger tube with plastic liner which was lead-filled at the upper end and which had water escape holes drilled below the lead, was used in an attempt to secure bottom samples. The bottom was too hard for penetration, however, and in only about 18 of the 28 holes was it possible to obtain any sediment at all and that consisted of only a few grains in most cases. A 35-lb. Phleger corer was slimmed down to fit the 8-inch hole but recovered very little more sediment from the bottom. On the second attempt with this instrument, it jammed in the hole coming up and the 3/32-inch wire broke. The "pipe" corer was used from then on; it weighed about 25 pounds and the impact on striking bottom was unmistakable. The locations of the two sounding lines are shown in Figure 1 (H. O. 6667). Direction of the lines in relation to prominent land features was determined by transit, and the distance between holes was paced off, holes being 300 yards apart in most cases. Plate VII shows trail along N-S sounding holes.

The next to the last hole near the southern boundary of the new fast ice was selected as the site for the oceanographic station, because the water beneath it was 579 meters deep and the ice was only 7 feet thick. By late March, it was decided to establish the

PLATE III. THE POLECAT, SNOW VEHICLE.

PLATE IV. ASSEMBLING THE SLED FOR BOTTOM SOUNDING.

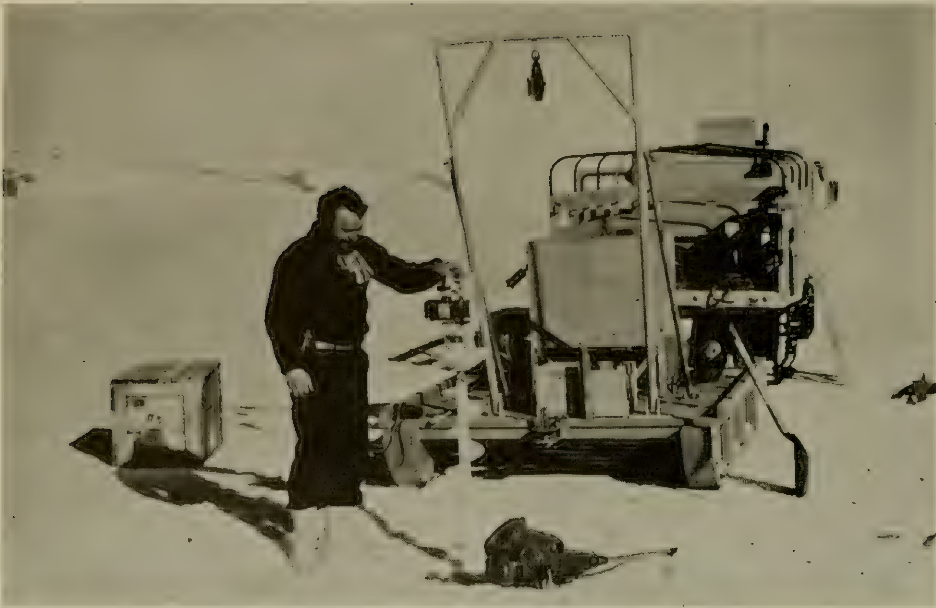

PLATE V. THE 8-INCH JIFFY POWER ICE DRILL.

PLATE VI. MAKING A BOTTOM SOUNDING. MT. EREBUS IN BACKGROUND.

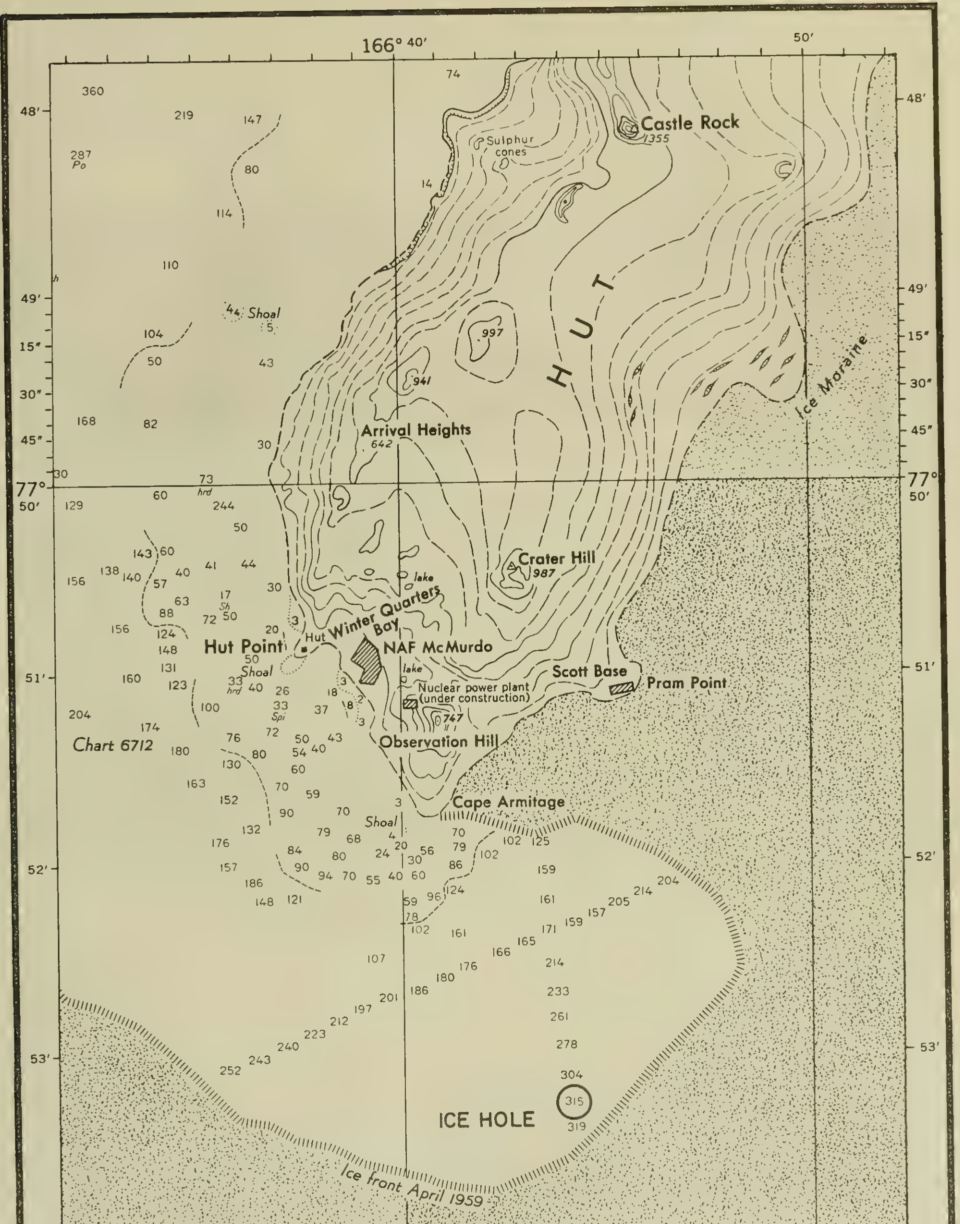

FIGURE 1. CHART OF THE NEW ICE AREA SOUTH OF CAPE ARMITAGE

PLATE VII. LOOKING BACK ALONG THE TRAIL. OBSERVATION HILL, THE GAP, AND CRATER HILL IN BACKGROUND.

icehole station, since it seemed improbable that there would be further break-out of fast ice. A hole five-feet square was drilled and chopped in the ice. This was commenced on 22 March 1960 and was dug out to a depth of 6 feet, but because of bad weather and other delays, it was impossible to blow out the bottom until 2 April. Meanwhile, the hole was covered with heavy canvas weighted down with timbers to prevent its filling up with snow. The upper three feet of the icehole was drilled, for the most part, using the 8-inch Jiffy drill and the 1-foot Remington power drill. Below that depth, it was found easier and quicker to chop with a Steuri pick and shovel out the chips. (Plates VIII & IX).

The icehole was lined by a heavy reinforced plywood box 4 feet square and 9 feet deep which in turn was lined with thick, heavy sheet metal. This was supported on the ice by two 4- by 8-inch timbers bolted on to the frame. The box with sheet metal liners attached was brought to the icehole unassembled because of the weight and bulk. The day the box was assembled there was an early cold snap and, in the afternoon, the temperature dropped to -47°F. Fortunately, there was no wind, but even then, driving nails was no fun. Once in the hole, the space between the liner and the icehole sides was packed with excelsior for insulation. (Plate X). On 5 April 1960, a 20- by 24-foot T-5 house was assembled over the hole. This hut was assembled from pre-constructed panels and is similar to a Clements hut, except that the roof, instead of being flat, has a low gable. (Plates XI, XII & XIII). Later the hut was tied down to the ice with cables attached to heavy deadmen rods which were frozen into the ice by drilling holes and filling them with water from the icehole. The T-5 hut had been built to order by the Coast Guard and had a $3\frac{1}{2}$-foot square hole in the deck to fit over the icehole.

PLATE VIII. FIRST STEP IN ERECTING THE ICEHOLE STATION; CHOPPING AND DRILLING THE 5-FOOT SQUARE HOLE.

PLATE IX. DRILLING THE UPPER PORTION OF THE ICEHOLE WITH 1-FOOT REMINGTON ICE AUGER.

PLATE X. THE ICEHOLE METAL LINER IN POSITION SHOWING EXCELSIOR PACKED AROUND IT.

PLATE XI. FOUNDATION BEAMS AND FIRST FLOOR PANEL OF THE ICEHOLE HUT IN PLACE.

PLATE XII. LOOKING SOUTH ALONG THE TRAIL TO THE ICEHOLE STATION. WHITE ISLAND, THE ICEHOLE HUT, AND BLACK ISLAND IN THE BACKGROUND. TRAFFIC REFLECTOR TYPE TRAIL MARKER IN FOREGROUND.

PLATE XIII. NORTH END OF ICEHOLE HUT SHOWING MODERATE SNOW ACCUMULATION WITH WIND SWEPT AREA ON EAST SIDE.

II. FIELD METHODS

A. Equipment

Once the hut was enclosed, the job of applying two coats of paint on the masonite deck, wiring the hut for lights and outlets, installing the winch, "A" frame, generator, building work tables, Nansen bottle racks, and other fixtures consumed more time. Many of the interior furnishings were not completed until mid-winter or later. (Plates XIV through XXIV). Two BuAir Aerial Target Towing Winches were modified to run on 110 volts instead of 28 volts and were used with 3/32-inch stainless steel cable which was run over a small meter wheel to determine depth. The winches were hydraulically controlled. Although excellent results were obtained from the little Onan $2\frac{1}{2}$ KW. generator on the sled in the cold air, it was found that indoors it produced just a little under the power required by the heavy winch motor. Accordingly, a large 10 KW. Hobart generator with a 4-cylinder gasoline motor was borrowed from the Navy. This gave excellent service with plenty of power and also was a splendid source of heat for the hut. In fact, when working at the icehole, the small Coleman space heater, which was kept going at all other times, was turned off. The temperature would quickly reach to 90° or 100° inside and work was performed in T-shirts with the outside door open at all times when there was not a strong wind blowing. This was really antarctic oceanography de luxe, and how different from the conditions under which the earlier investigators worked!

The icehole hut was located 2 miles south of the southern end of the Gap through which the main road from NAF McMurdo to Scott Base at Pram Point runs. The eleven sounding holes along the route to the icehole already had been marked with small snow cairns and bamboo poles with flags. Before winter darkness set in, a large number of split bamboo poles with flags, some of which had a 4-inch band of Scotchlite luminous tape on them, were interspersed with the cairns. These showed up in the headlights very nicely but not nearly as brilliantly as the 40 or so traffic reflectors which were set up at regular intervals. (Plate XII). At close range, these markers showed up like a flaming torch in the rays of the Polecat's spotlight. On a clear winter's night one could see over a mile of reflectors running down the trail to the hut. These reflectors, flags, and Scotchlite taped poles were all a big help on numerous occasions when it was necessary to blindly grope one's way shoreward in the midst of a raging blizzard. On one abortive trip to the icehole, it was deemed wise to turn around at the pressure ridges, since it was simply impossible to see any flags at all and the tracks were blown over. Returning to the base of the Gap, it was necessary for the second author to go ahead at the end of a 100-foot rope attached to the Polecat to locate the trail. When they

PLATE XIV. INSIDE ICEHOLE HUT SHOWING WORK BENCH.

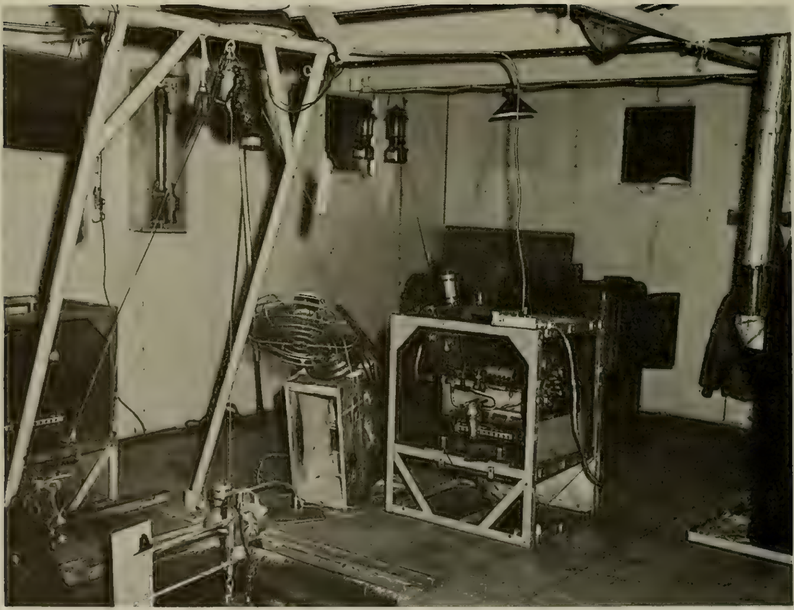

PLATE XV. INSIDE ICEHOLE HUT SHOWING 10-KW HOBART GASOLINE POWERED GENERATOR AND ONE HYDRAULIC-ELECTRIC OCEANOGRAPHIC WINCH.

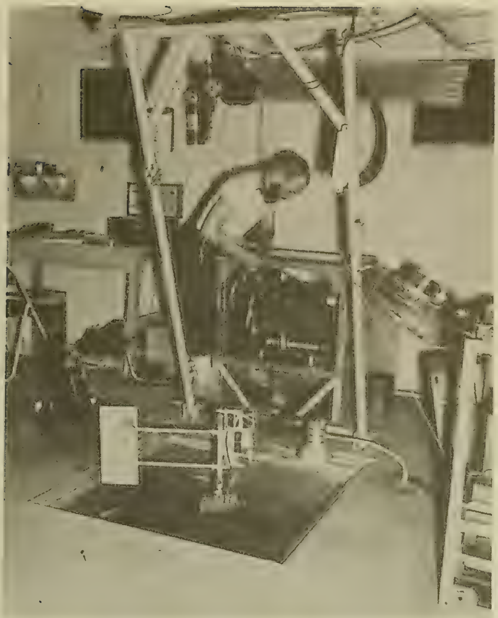

PLATE XVI. INSIDE ICEHOLE HUT SHOWING A-FRAME AND EKMAN CURRENT METER.

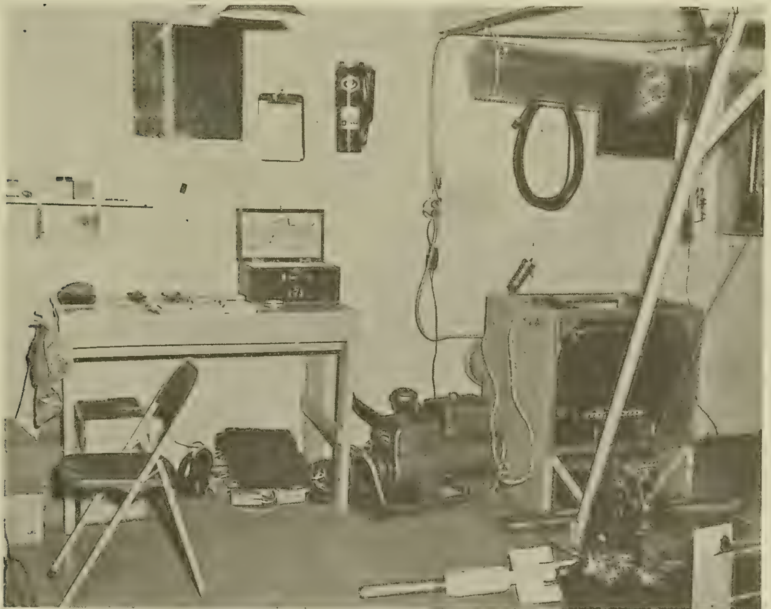

PLATE XVII. INSIDE THE ICEHOLE HUT SHOWING WORK TABLE, 2 1/2-KW ONAN AUXILLARY GENERATOR, AND HYDRAULIC-ELECTRIC WINCH.

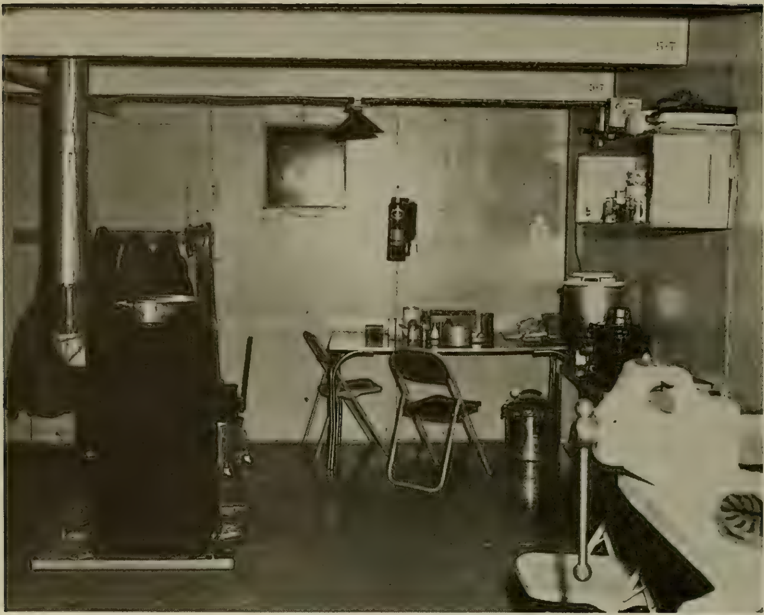

PLATE XVIII. INSIDE ICEHOLE HUT SHOWING LUNCH TABLE, COLEMAN SPACE HEATER, AND SNOW MELTER.

PLATE XIX. LOWERING SMALL ORANGE PEEL BOTTOM SAMPLER.

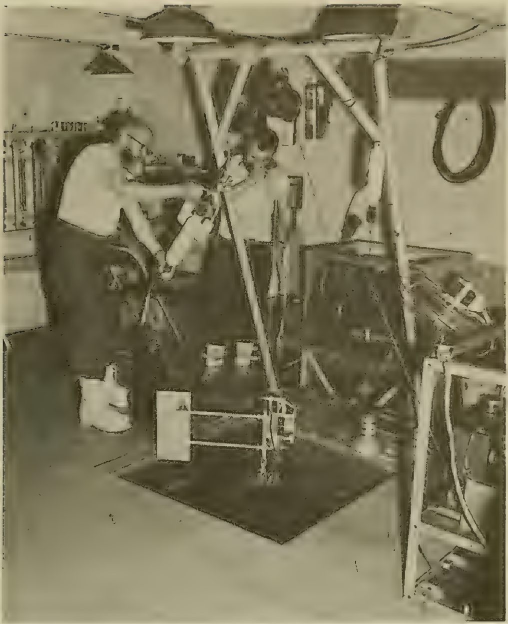

PLATE XX. PREPARING PHLEGER CORER. EKMAN CURRENT METER SUSPENDED FROM SECOND WINCH.

PLATE XXI. INSTALLING REVERSING THERMOMETERS ON NANSEN BOTTLES.

PLATE XXII. ADJUSTING EKMAN CURRENT METER; SMALL PHLEGER CORER IN BACKGROUND.

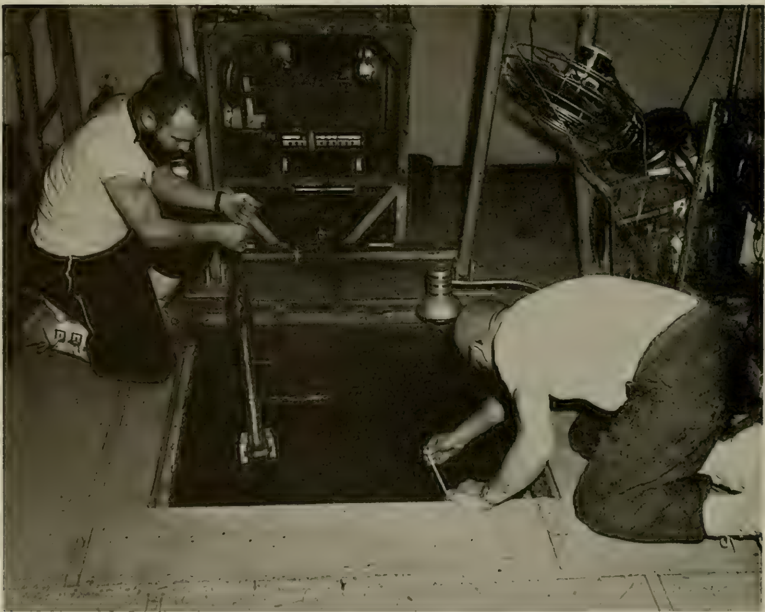

PLATE XXIII. TAKING SURFACE TEMPERATURE BEFORE MAKING A BATHYTHERMOGRAPH DROP.

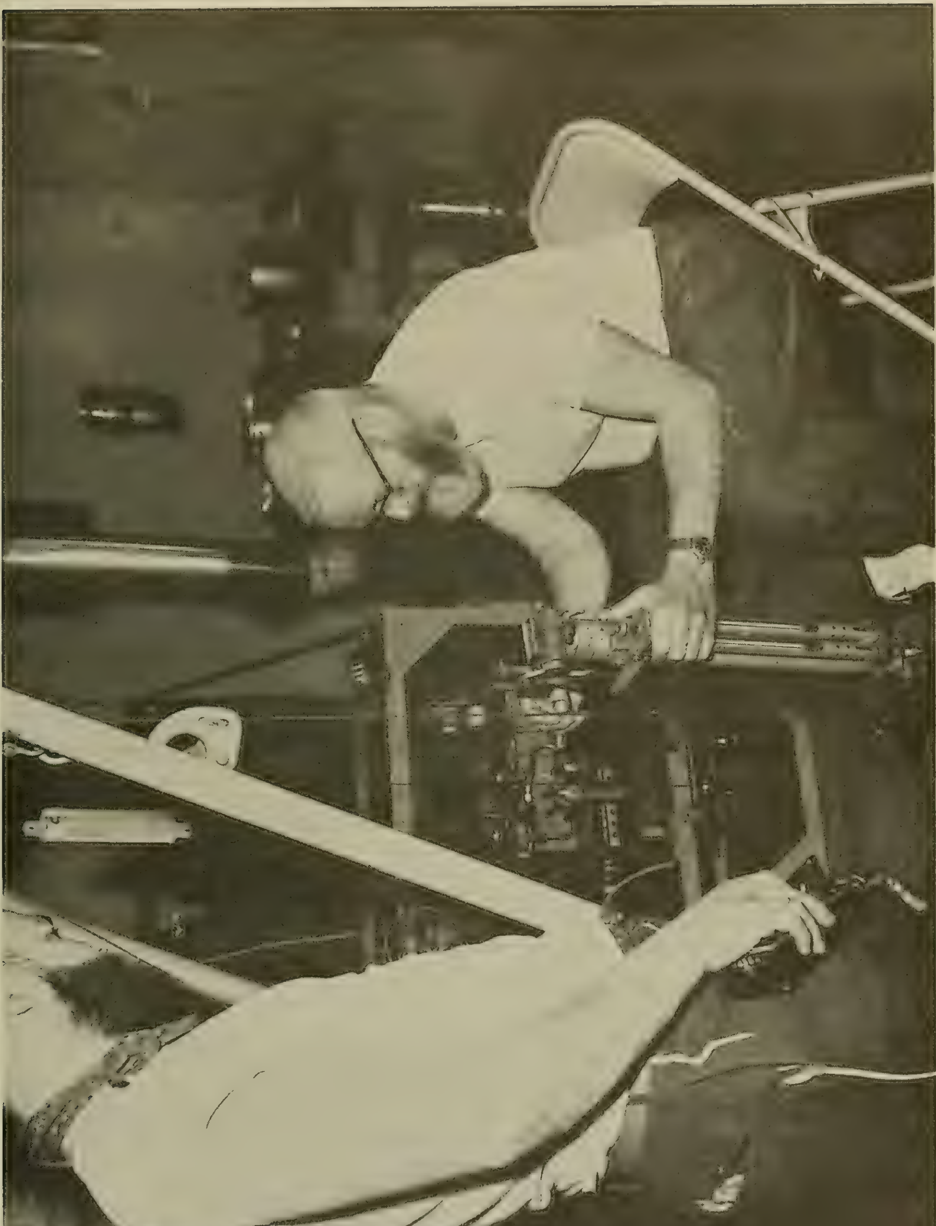

PLATE XXIV. HANGING NANSEN BOTTLE ON THE WIRE.

were not overblown by snow, the vehicle tracks on the trail were our best means of direction.

A snow vehicle, the Polecat, (Plate XXV) was maintained for the exclusive use of this project, a precaution which, when possible, insures that a vehicle in good running order will be available most of the time, at least. The Polecat is an articulated vehicle built on two sets of weasel tracks and undercarriages, all four tracks being power-driven by a 130 h.p. International Harvester motor with manual gear shift. It had a very low ground pressure and was excellent for our purposes in every respect. It gave, and is still giving, very reliable service. New specially constructed tracks good to -60°F., which were installed just previous to the author's departure from McMurdo, should prove adequate for all except the very occasional extremes of temperature on the ice during the winter. During the following winter, the new tracks were used without any difficulty in temperatures as low as -68°F. It also should be mentioned that the Polecat was the one snow vehicle which could be depended upon during the second winter of operation when it was used by biologists from Stanford University.

B. Water Samples

Water samples were obtained with standard Nansen bottles placed 6 to a cast; 3 casts were made at each station, thus obtaining information at all standard depths plus some additional depths. Paired protected reversing thermometers on each bottle were used for water temperatures. Unprotected thermometers were not used because of the comparatively shallow depth and also because with the heavy weight used, there was rarely any wire angle. Wire angle sometimes gave trouble when using the Ekman current meter with its much lighter weight, and care had to be exercised in raising the meter past the bottom edge of the sheet metal lining of the icehole. Having a warm (usually too warm) hut to work in, there was no trouble with water samples freezing in the Nansen bottles and having to be brought into the laboratory for thawing out, a situation much deplored by the Australians (Bunt, 1960). Thermometers were read as soon as they reached room temperature after the water samples had been taken and the bottles drained.

C. Dissolved Oxygen and Salinity

Samples for oxygen determination were collected in ground glass-stoppered bottles and titrated in the laboratory. Salinity samples were drawn off in Citrate of Magnesia bottles and sent back to the Hydrographic Office where more accurate determinations were made. Bathythermograph drops were made to about 900 feet at each station

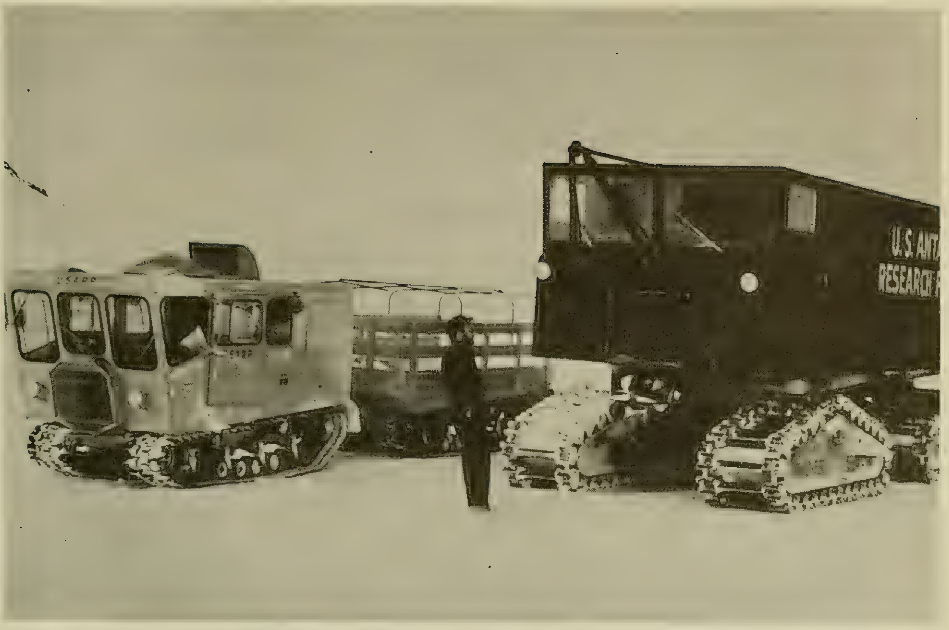

PLATE XXV. THE POLECAT ALONGSIDE ONE OF THE LARGE SNOCATS USED BY DR. CRARY ON THE POLE TRAVERSE.

and also at other times, but the temperature change was so slight that it barely showed on the slide.

D. Transparency

Transparency observations using a 30-cm. white Secchi Disc were made using artificial light. Later on, rust from the sheet metal lining of the icehole fouled the water to an extent where readings were not considered reliable and they were discontinued. There was no opportunity to make correlations with transparency observed in open water under natural sunlight, so the results obtained are largely relative in value.

E. Current and Biological Observations

Current observations were made with a standard Ekman meter which was lowered on the regular winch wire. Much of the time two winches were in operation, one of which could be used to lower a fish trap while the other was employed in oceanographic work. Fish traps were kept down over night and collected besides fish, various crustaceans and other bottom invertebrates. A bottom tangle also was used at times.

F. Bottom Samples

A 35-pound Phleger corer was tried a number of times at the icehole but with very little success, the very hard bottom permitting little or no penetration. The performance of a small Orange-peel sampler was also disappointing. Finally, an 80-pound Peterson bottom sampler, similar to ones used by the senior author on Wisconsin lakes during the 1920's, was tried and proved very successful in obtaining large amounts of bottom sediment. Bottom samples were placed in quart Mason jars and kept wet; a little formalin was added to preserve any soft bodied forms. The larger bottom organisms were picked out from the sediment and given to the Stanford University biologists.

G. Meteorology

Meteorological conditions at the icehole were often at great variance with those reported by the Navy Meteorological Station at NAF McMurdo. Lack of instruments at the icehole precluded maintenance of a separate weather record except for air temperatures, visual observations, and general weather conditions. During the latter part of the winter a grasshopper automatic weather transmitter was installed for several weeks and a barometer was located inside the hut. The day the grasshopper was put down it was $-58^{\circ}F$.

or within 2 degrees of the lower limit of operation for this instrument. This caused very slow sending until the temperature warmed up. The grasshopper transmitted weather conditions (temperature, wind speed and direction, and barometric pressure) every 6 hours and, for a time, two grasshoppers were used staggered to give reports every 3 hours.

III. FIELD PROBLEMS

One of the problems which faced the investigators was that of keeping the icehole free of ice during the winter. Keeping the space heater going continuously, except when operating the generator, solved most of the difficulty, but on one or two occasions the heater went out and the inside temperature dropped to below zero. Despite this, ice never accumulated at the surface of the icehole to a greater thickness than about 10 inches and, when it did form, it was usually only a skim or at most a few inches. This was easily chopped and shoveled out of the hole. During the winter, a 6,000 watt Navy electric immersion heater was installed in the hole and kept going whenever the generator was running. This was of considerable help in keeping the hole free of ice. In the spring, trouble was experienced with ice forming three to five feet down along all sides of the sheet metal lining. This became thick enough to prevent using the Ekman current meter. Chopping with ice chisels, drilling with the Jiffy drill, circulating warmer air with an electric fan, and bubbling water from the surface finally overcame this difficulty, and the hole was kept completely free of ice. A lone seal, who discovered and made his home in and near the icehole for a month in early spring, also aided in circulating the water in the hole and melting the formed ice. During the summer a number of seals became a real nuisance; three of them at a time trying to get up in the icehole for air. Current observations finally had to be discontinued because of the seals. Their fondness for rubbing their backs along the winch wire, completely distorting direction recording in the Ekman meter. There were at least seven seals at the hole at one time, as some of the biologists painted numerals on their heads when they came up, thus identifying them in this way.

Another problem encountered at the icehole was snow accumulation. (Plates XXVI through XXVIII). The hut soon became drifted up to the eaves on two sides, the others being kept clear for a space by winds. The door faced north and heavy winds from the south during the winter soon piled the snow to the roof on this side. This necessitated shoveling ones way in on most trips to the icehole. During a few of the most severe storms, a little snow was blown inside. Most of this snow came up through the icehole where minute cracks outside and between the top of the liner and the deck allowed very strong winds to force their way in. However, the worst trouble with snow accumulation was the piling up of six-foot drifts all around the hut. The weight of this accumulation caused the ice to sink, and this brought the water level in the icehole higher and higher until it was feared that Van der Hoven's measures might have to be adopted and a false deck built to get above the water. However, bulldozing away

PLATE XXVI. SNOW ACCUMULATION AROUND ICEHOLE HUT.

PLATE XXVII. BULLDOZING AWAY THE SNOW ACCUMULATION WITH LOW GROUND PRESSURE D-8 TRACTOR AND 16-FOOT BLADE. ROYAL SOCIETY RANGE ACROSS MCMURDO SOUND IN BACKGROUND.

PLATE XXVIII. EAST SIDE OF ICEHOLE HUT SHOWING SNOW ACCUMULATION PARTIALLY REMOVED. MT. DISCOVERY IN LEFT BACKGROUND.

the snow for about 75 feet on all sides of the hut caused the ice to spring back into place and resume its former level; the water level in the icehole dropped accordingly. Snow removal was resorted to on three occasions. A large Navy D-8 tractor with 16-foot blade would do the job in less than a day. Finally, the hut rested in what appeared to be a shallow depression with high banks of snow surrounding it at a distance of 100 feet on all sides.

IV. LABORATORY METHODS

A. Dissolved Oxygen

Water samples and bottom samples were brought into the laboratory at the main base in the heated cab of the Polecat snow vehicle. At NAF McMurdo, Stanford University had established a remarkably well equipped biological laboratory. Erected in 1959, the size of the building was more than doubled during the following year. It is now a structure 20 feet wide and some 120 feet in length and is equipped with refrigerators, freezers, an autoclave, a microfilming and viewing apparatus, constant temperature cold water aquaria, and in fact everything required for advanced biological work. Oxygen samples were titrated in the biological laboratory (Plate XXIX) after being "doped" immediately after each cast at the ice-hole hut. The standard Winkler method was employed, two 100-cc samples being titrated. The sodium thiosulphate solution was standardized, and a blank test made before each station run.

B. Salinity

Salinity samples were stored in tight-stoppered Citrate of Magnesia bottles and were shipped to the oceanographic laboratory of the U. S. Navy Hydrographic Office where salinities were run on a University of Washington conductivity bridge (salinometer). Duplicate runs were made on each sample. Accuracies are considered good to within 0.01 $^{o}/oo$.

C. Conductivity and pH

On one occasion, conductivity tests were made by diluting the sample of water 1 to 1,000 parts in order to bring the values down to the scale of the Evershed and Vignoles field conductivity meter, which was intended for freshwater use. Values of pH also were determined on one occasion using a Beckman pH meter.

PLATE XXIX. DISSOLVED OXYGEN TITRATION APPARATUS IN THE STANFORD UNIVERSITY BIOLOGICAL LABORATORY AT NAF MCMURDO.

V. PHYSICAL PROPERTIES

Below a depth of 200 meters, all physical oceanographic factors showed remarkably constant values. This also was true of the water above 200 meters throughout the winter and until mid-December. Following this date, pronounced micro-changes appeared in all physical factors, commencing in the upper levels and spreading progressively into the waters above 200 meters. The greatest stratification was observed on 10 January 1961.

The reasons for these changes, which produced stratification from a condition of very uniform vertical distribution, are discussed under the individual factors. These include increased solar energy absorption, rising air and water temperatures, and inflow of foreign water masses. During the entire period of observation (May 1960 to early March 1961), the area was ice-covered, the nearest open water never being closer than 3 or 4 miles. On 10 March 1961, following a strong gale, the ice broke out rapidly throughout the region taking the icehole hut with it, and thus all observations were terminated. (Plate XXX). It is expected that removal of the 2-year old ice cover also produced changes in the values of physical oceanographic factors, in the upper waters, at least.

A. Temperature

At depths below 200 meters, water temperatures were very constant at any particular level. (Table 1). This also is shown in Figure 2. Table 2 gives the ranges for temperature at different depths at the icehole during the period May through November for winter observations and from November to March for summer observations, and also emphasizes the remarkable uniformity in the lower two-thirds of the water column. Although surface temperatures were taken 1 meter below the surface, being within the metal encased icehole, they represent less the actual conditions than the condition of the heat in the hut during the days prior to each observation; they were very variable.

Commencing in mid-December, there was a sudden upward trend in water temperatures above 100 meters and, by January, this had extended downward to the 200 meter level (Fig. 2). Maximum stratification was reached at the 10 January observation and is shown graphically in Figure 3. By comparison, a mid-winter vertical profile, shown in Figure 4, is very uniform. Following the time of maximum stratification, the water above 30 meters dropped in temperature but, below this depth, temperatures down to the 200 meter level continued to rise until well through February. The

PLATE XXX. ICE BREAK-UP 10 MARCH 1961. ICEHOLE HUT IN FOREGROUND. HUT POINT IN BACKGROUND WITH LOWER SLOPES OF OBSERVATION HILL TO THE RIGHT.

TABLE 1. SEASONAL VARIATION OF WATER TEMPERATURE AT DEPTH AT THE ICEHOLE

DEPTH	1960 MAY			JUNE			JULY			AUGUST		SEPTEMBER		OCTOBER			NOVEMBER			DECEMBER		1961 JANUARY			FEBRUARY			MARCH
	4	16	[illegible]	[illegible]	[illegible]	[illegible]	10	20	[illegible]	22	31	9	[illegible]	2	12	23	7	17	[illegible]	12	23	4	10	[illegible]	1	9	21	7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.67	1.39	[illegible]	[illegible]	1.86	1.42	[illegible]	1.83	[illegible]	1.29	[illegible]	[illegible]	1.65	[illegible]	[illegible]	1.43	1.51	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	-	[illegible]	[illegible]	1.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.92	[illegible]	1.93	[illegible]	[illegible]	[illegible]	[illegible]	1.90	1.75	1.73	1.42	1.71	1.83	[illegible]	[illegible]	1.83
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]	1.92	1.90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.94	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.53	[illegible]	[illegible]	[illegible]	1.65	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.93	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	-	[illegible]	[illegible]	[illegible]	1.79	1.61	[illegible]	[illegible]	[illegible]	[illegible]	1.71
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	1.90	1.91	[illegible]	[illegible]	1.93	1.94	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.80	1.61	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.88	[illegible]	1.88	[illegible]	[illegible]	[illegible]	1.90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.61	[illegible]	[illegible]	[illegible]	1.81	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	1.90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.90	1.84	[illegible]	[illegible]	[illegible]	[illegible]	1.74	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1.92	[illegible]	1.91	1.92	1.92	[illegible]	[illegible]	1.92	1.92	1.93	[illegible]	1.94	[illegible]	[illegible]	[illegible]	[illegible]	1.90	[illegible]	1.88	[illegible]	1.91	1.91	1.91	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.88	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.90	1.91	1.92	1.91	[illegible]	1.91	1.92	[illegible]	1.91	[illegible]	1.89	[illegible]	1.92	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.90	[illegible]	[illegible]	1.92	[illegible]	[illegible]	[illegible]	1.88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.88	1.57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	[illegible]
Bottom	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	1.91	[illegible]	1.90	[illegible]	1.90													
												[illegible]			1.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.86	[illegible]	1.87	[illegible]	[illegible]	1.86	1.86	[illegible]

TEMPERATURE (-°C)

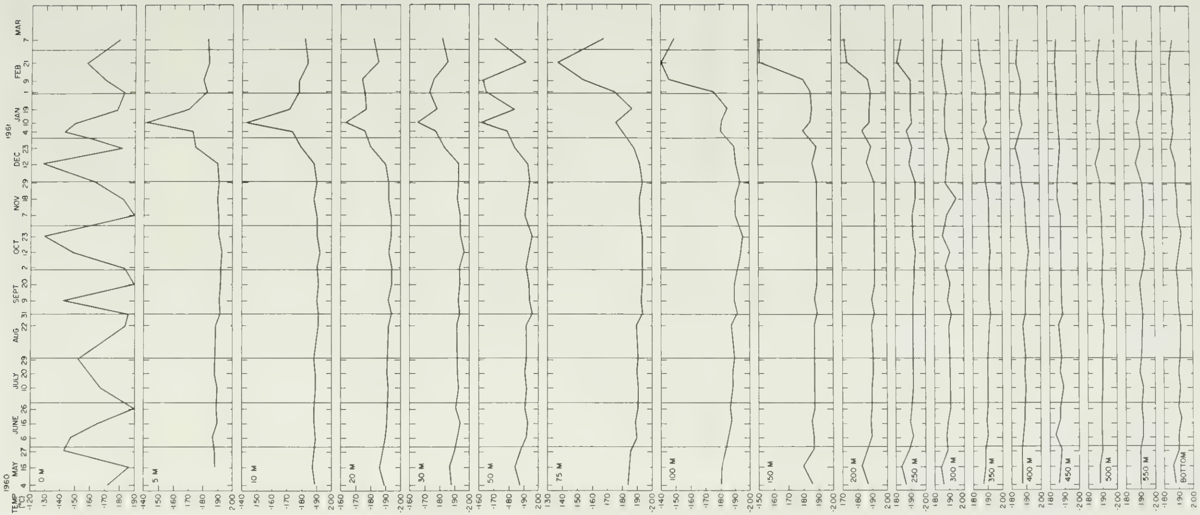

FIGURE 2. SEASONAL VARIATION OF WATER TEMPERATURES AT DEPTH AT THE ICEHOLE

TABLE 2. WATER TEMPERATURE, MEANS AND RANGES AT THE ICEHOLE

DEPTH (M)	TEMPERATURE (- °C)					
			SUMMER (MAY-OCT)		WINTER (NOV-MAR)	
	MEAN	EXTREME	MEAN	RANGE	MEAN	RANGE
0	1.66	0.61	1.67	0.47	1.65	0.61
5	1.85	0.51	1.73	0.48	1.90	0.06
10	1.85	0.49	1.73	0.47	1.89	0.05
20	1.86	0.41	1.74	0.41	1.91	0.08
30	1.88	0.32	1.75	0.29	1.92	0.07
50	1.87	0.35	1.80	0.33	1.92	0.12
75	1.85	0.57	1.78	0.57	1.91	0.10
100	1.83	0.56	1.75	0.54	1.89	0.15
150	1.85	0.38	1.81	0.38	1.88	0.10
200	1.88	0.20	1.87	0.22	1.90	0.09
250	1.91	0.12	1.83	0.12	1.91	0.10
300	1.89	0.11	1.86	0.09	1.89	0.08
350	1.90	0.07	1.86	0.07	1.90	0.05
400	1.88	0.07	1.88	0.06	1.83	0.05
450	1.87	0.04	1.87	0.03	1.87	0.03
500	1.86	0.05	1.89	0.04	1.90	0.03
550	1.91	0.06	1.90	0.05	1.91	0.04
Bottom	1.89	0.07	1.88	0.04	1.90	0.07

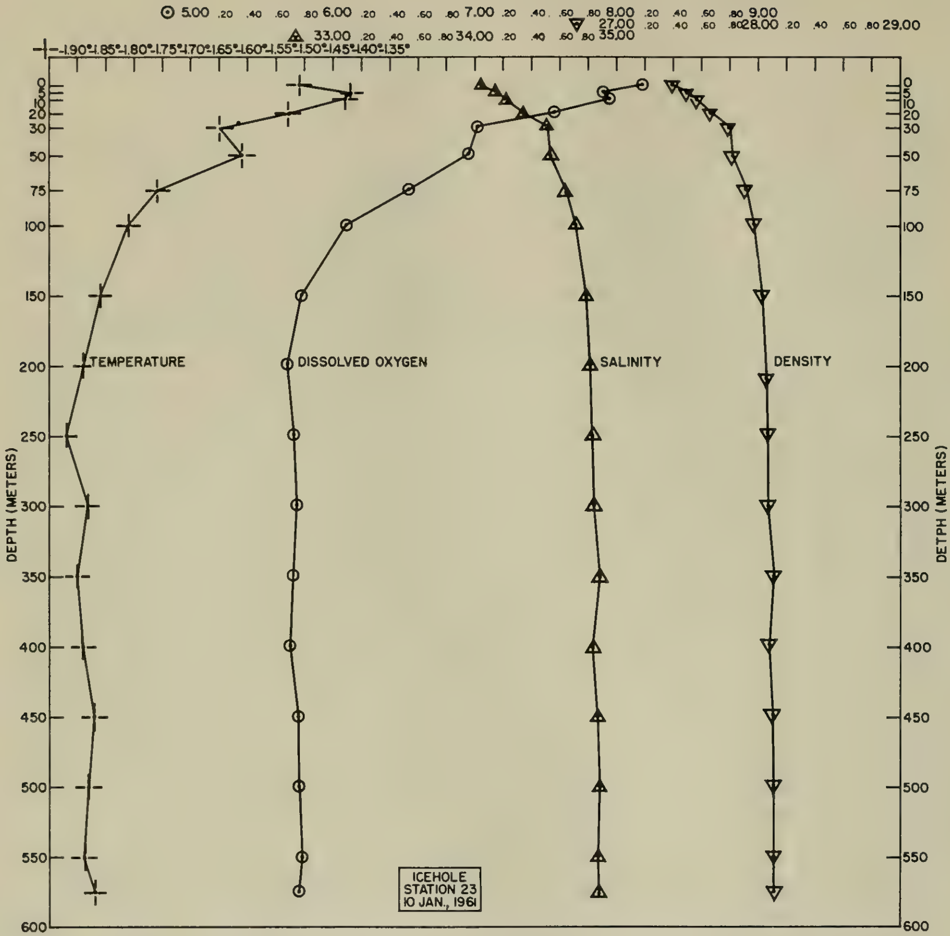

FIGURE 3. VERTICAL DISTRIBUTION OF TEMPERATURES, DISSOLVED OXYGEN, SALINITY, AND DENSITY, DURING THE SUMMER PERIOD

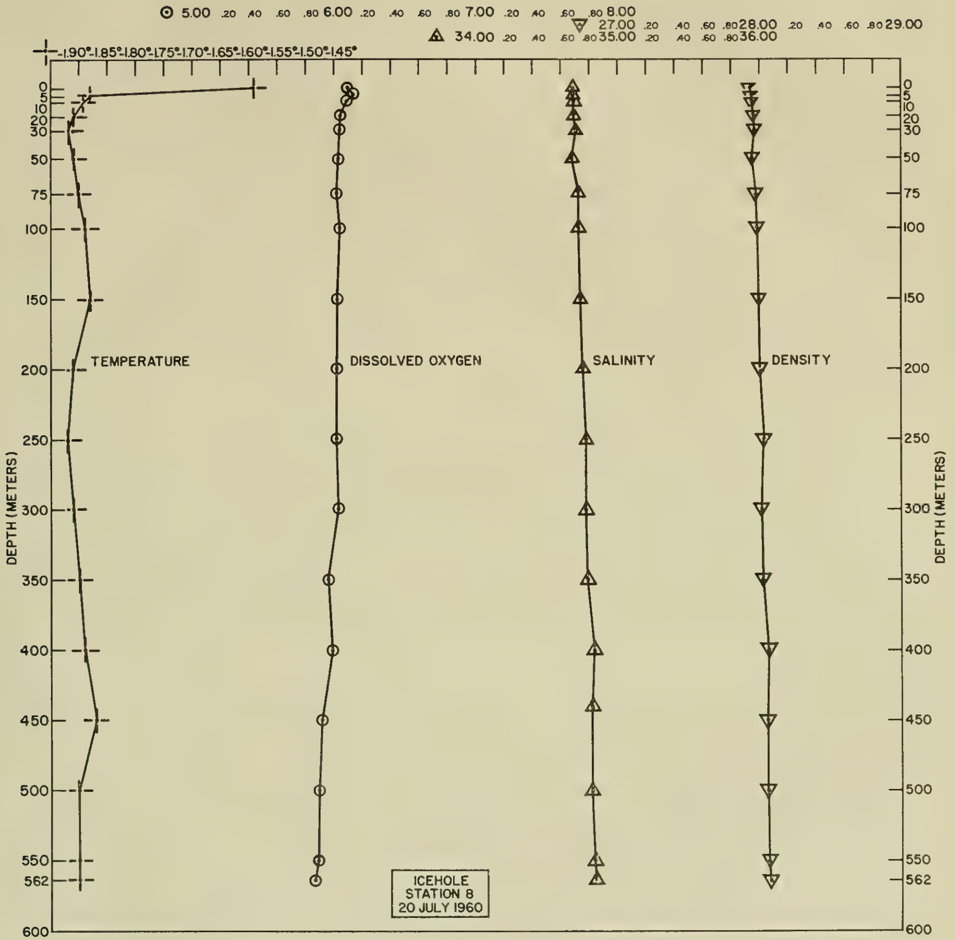

FIGURE 4. VERTICAL DISTRIBUTION OF TEMPERATURES, DISSOLVED OXYGEN, SALINITY, AND DENSITY, DURING THE WINTER PERIOD

highest temperature observed at depth was $-1.37^{\circ}C$. occurred at 75 meters on 21 February 1961. This is exclusive of the highly variable surface temperatures, the highest at this level was $-1.29^{\circ}C$. on 12 December 1960. The lowest temperature observed at depth was $-1.97^{\circ}C$. at 30 meters on 12 October 1960. Surface temperatures, obtained by immersing a thermometer a few inches beneath the surface when making a BT drop, showed $-2.78^{\circ}C$. on 29 November 1960 and 9 February 1961 and a second reading of $-3.00^{\circ}C$. on 9 February. These low temperatures were caused by supercooling in the confined area of the icehole, surrounded as it was by 11 feet of ice. Supposedly, below-freezing temperatures such as these also were noted by the Australians at Mawson (Bunt, 1960) where temperatures of $-2.10^{\circ}C$. and $-2.20^{\circ}C$. were recorded at 0 and 5 meters. Surface temperatures down to $-3.00^{\circ}C$. were observed. In March 1956 in the absolutely calm and open water of Vincennes Bay off the Balaena Islets, the senior author recorded $-2.13^{\circ}C$. on two reversing thermometers which were lowered just below the surface (U. S. Navy Hydrographic Office TR-33, 1956).

Two apparently anomalous temperatures were recorded at the icehole. Since only one reversing thermometer reversed properly, they are not included in the tabulated records. On 29 July 1960, a temperature of $-2.02^{\circ}C$. was noted on one thermometer at 300 meters, with temperatures of $-1.92^{\circ}C$. and $-1.90^{\circ}C$. above and below it respectively. On 18 November 1960 at 50 meters, $-1.70^{\circ}C$. was noted while the temperatures above and below were $-1.92^{\circ}C$. Both of these depths are levels at which maximum current activity was noted, so that it is possible that the temperatures observed may have been true.

In Figure 5 temperature has been plotted against salinity for winter and summer stations. In this figure, the winter salinity scale was shifted 0.30 $^{\circ}/oo$ to the left to avoid superposition of the two curves at lower levels. During the summer period of maximum stratification, it is noted that temperature-salinity relations, from 5 meters down to 250 meters, show a fairly even progression, with one minor exception at 50 meters where currents may account for the temperature rise. Below 250 meters, however, there is a confused pattern which simply indicates more or less uniform conditions in both temperatures and salinity. Temperature-salinity relations in mid-winter are markedly different; uniform conditions prevail throughout the entire water column (if surface temperature is disregarded).

B. Salinity

During the winter from May to early November, salinity showed a definite and steady upward trend as shown in Table 3 and Figure 6.

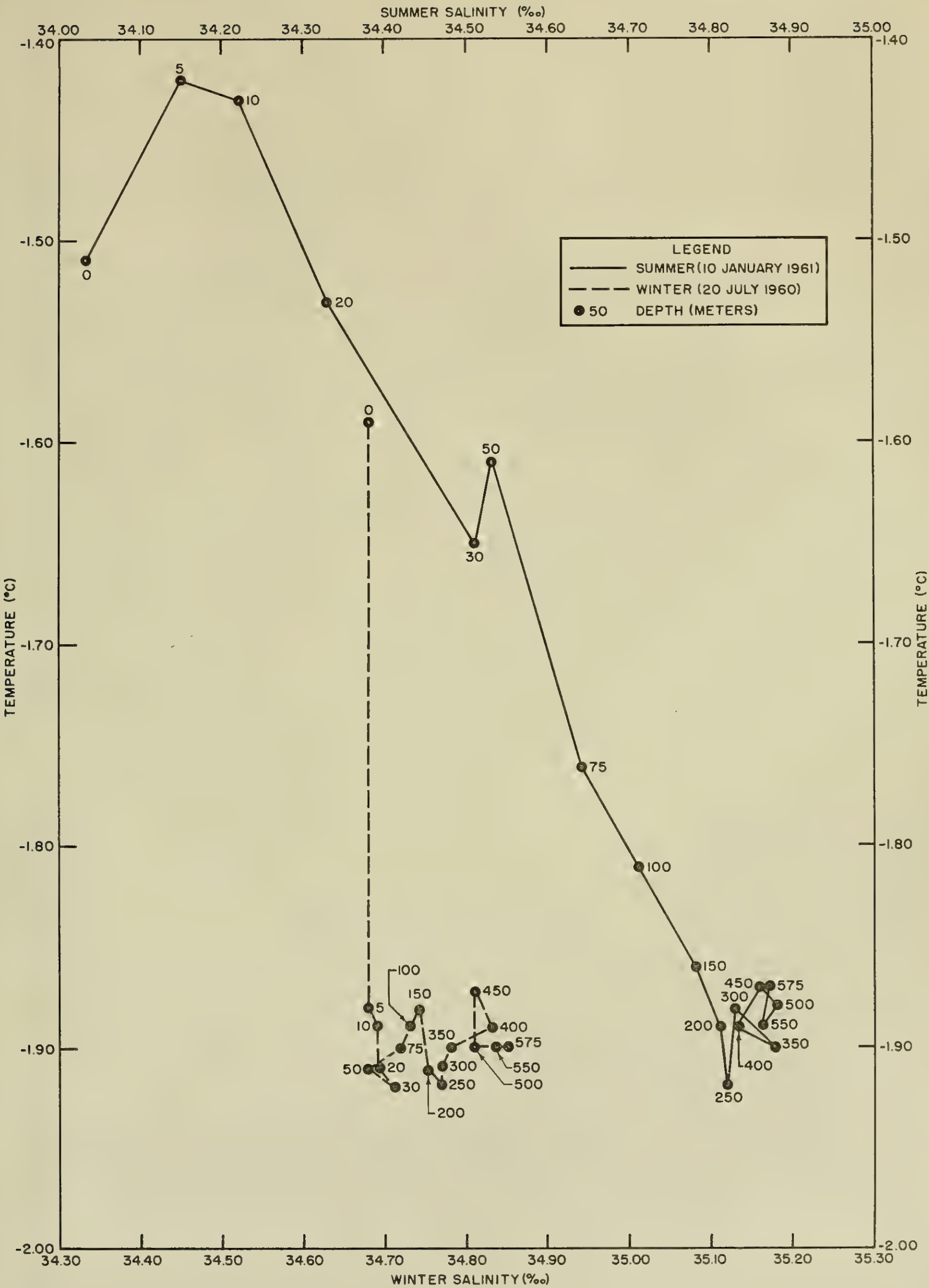

FIGURE 5. TEMPERATURE/SALINITY RELATIONSHIPS IN MID-SUMMER AND MID-WINTER

TABLE 3. SEASONAL VARIATION OF SALINITY AT DEPTH AT THE ICEHOLE

DEPTH	1960 MAY			JUNE			JULY			AUGUST		SEPTEMBER		OCTOBER			NOVEMBER			DECEMBER		1961 JANUARY			FEBRUARY			MARCH
(M)	4	16	27	6	16	26	10	20	29	22	31	9	20	2	12	23	7	17	29	12	23	4	10	19	1	9	21	7
0	34.45	34.51	34.59	34.42	34.59	34.55	34.66	34.68	34.65	34.64	34.70	34.63	34.71	34.47	34.71	34.73	34.77	34.71	34.76	34.75	34.48	34.63	34.03	34.18	34.21	34.03	34.01	34.04
5	-	34.54	34.59	34.57	34.60	34.64	34.65	34.68	34.67	34.72	34.72	34.75	34.73	34.74	34.73	34.76	34.76	34.71	34.78	34.76	34.59	34.71	34.15	34.26	34.26	34.03	34.04	34.05
10	34.48	34.54	34.61	34.57	34.50	34.64	34.56	34.69	34.67	34.73	34.71	34.74	34.73	34.73	34.76	34.76	34.76	34.70	34.77	34.77	34.53	34.72	34.22	34.28	34.27	34.08	34.00	34.09
20	34.48	34.56	34.60	34.61	34.60	34.55	34.66	34.69	34.68	34.74	34.86	34.79	34.75	34.73	34.73	34.80	34.79	34.70	34.77	34.76	34.53	34.72	34.33	34.31	34.33	34.15	34.00	34.07
30	34.52	34.56	34.62	34.57	34.60	34.55	34.65	34.71	34.68	34.73	34.72	34.74	34.70	34.70	34.73	34.74	34.78	34.70	34.77	34.75	34.53	34.76	34.51	34.33	34.35	34.21	34.03	34.05
50	34.52	34.59	34.63	34.57	34.50	34.55	34.68	34.68	34.69	34.74	34.72	34.76	34.73	34.74	34.78	34.74	34.79	34.70	34.79	34.77	34.67	34.74	34.53	34.71	34.50	34.34	34.33	34.20
75	34.54	34.59	34.58	34.59	34.56	34.57	34.71	34.72	34.71	34.74	34.74	34.76	34.73	34.76	34.72	34.75	34.81	34.71	34.78	34.77	34.71	34.75	34.64	34.71	34.60	34.43	34.41	34.27
100	34.60	34.62	34.66	34.62	34.58	34.66	34.72	34.73	34.72	34.76	34.76	34.80	34.76	34.77	34.73	34.77	34.81	34.71	34.80	34.70	34.70	34.76	34.71	34.71	34.65	34.50	34.52	34.38
150	34.67	34.65	34.69	34.70	34.71	34.70	34.73	34.74	34.74	34.76	34.77	34.78	34.78	34.81	34.77	34.81	34.85	34.72	34.81	34.77	34.74	-	34.78	34.79	34.79	34.64	34.63	34.45
200	34.68	34.57	34.72	34.73	34.72	34.75	34.75	34.75	34.76	34.77	34.79	34.78	34.79	34.81	34.80	34.83	34.83	34.75	34.83	34.81	34.76	34.80	34.81	34.79	34.64	34.74	34.67	34.47
[illegible]	34.71	34.68	34.73	34.74	34.73	34.75	34.76	34.77	34.77	34.78	34.78	34.81	34.78	34.80	34.80	34.84	34.84	34.76	34.87	34.78	34.74	34.82	34.82	34.51	34.78	34.76	34.70	34.54
[illegible]	34.73	34.59	34.73	34.75	34.76	34.76	34.78	34.77	34.77	34.79	34.79	34.81	34.81	34.82	34.83	34.83	34.94	34.83	34.84	34.78	34.77	34.66	34.83	34.81	34.80	34.78	34.75	34.56
[illegible]	34.72	[illegible]	[illegible]	34.7[illegible]	34.77	34.79	34.7[illegible]	34.78	34.77	34.81	34.79	34.82	34.82	34.82	34.83	34.84	34.78	34.79	34.87	34.77	34.86	34.86	34.80	34.66	34.60	34.61	34.70	34.58
[illegible]	34.79	34.75	34.75	34.81	34.80	34.79	34.80	34.83	34.77	34.82	34.83	34.84	34.82	34.82	34.87	34.86	34.70	34.79	-	34.79	34.85	34.87	34.83	34.86	34.81	34.81	34.79	34.58
[illegible]	[illegible]	34.76	34.74	34.79	34.78	[illegible]	[illegible]	34.81	34.79	34.81	34.82	34.85	34.84	34.83	34.87	34.85	34.81	34.80	34.90	34.79	34.90	34.67	34.66	34.66	34.87	34.83	34.77	34.58
[illegible]	[illegible]	34.66	34.76	34.79	34.79	34.80	[illegible]	34.81	34.80	34.83	34.85	34.86	34.85	34.86	34.87	34.87	34.85	34.80	34.90	34.78	34.88	34.88	34.88	34.87	34.88	34.55	34.66	34.59
[illegible]	[illegible]	34.79	34.75	34.78	34.81	34.80	[illegible]	34.83	34.81	34.84	34.84	34.85	34.86	34.86	35.02	34.87	34.85	34.83	34.90	34.78	34.91	34.88	34.66	34.88	34.88	34.88	34.52	34.72
[illegible]	34.80	34.78	34.81	34.80	34.80	34.80	34.81	34.84	34.82	34.84	34.85	34.86	34.86	34.88	34.88	34.88	34.91	34.83	34.91	34.81	34.93	34.89	34.87	34.89	34.90	34.96	34.63	34.72

SALINITY (‰)

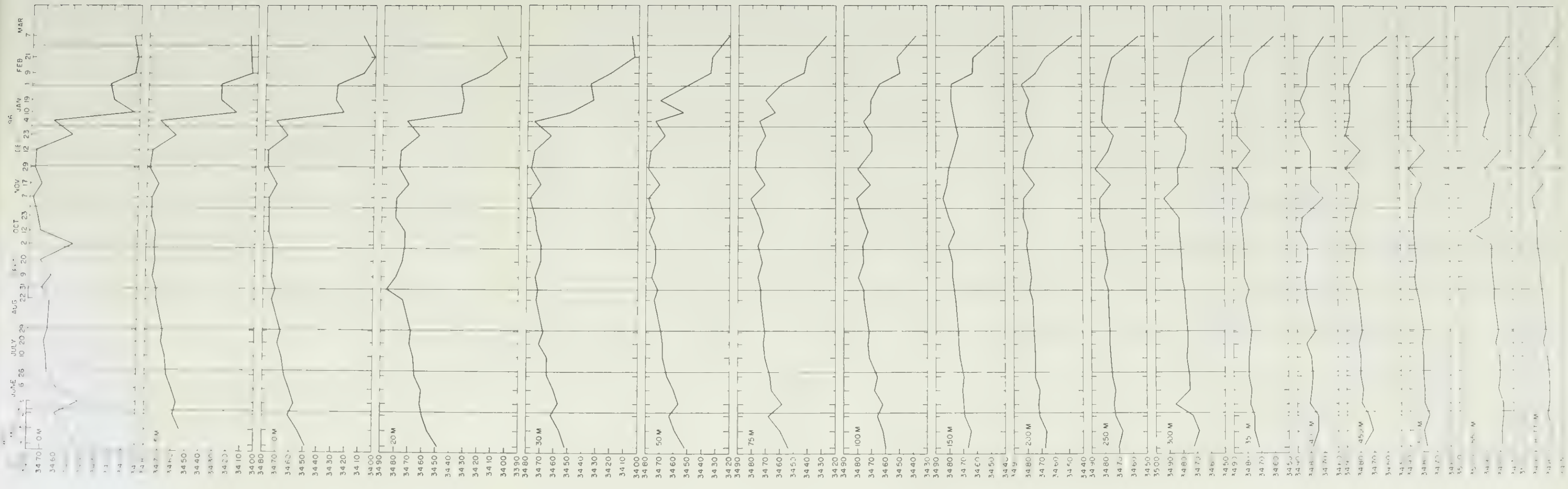

FIGURE 6. SEASONAL VARIATION OF SALINITY AT DEPTH AT THE ICEHOLE

While this steady increase extended from the surface down to 300 meters, it was considerably more pronounced above 200 meters. An insignificant drop in mid-November which extended down to 300 meters, was followed by a return to previous levels until mid-December when the summer decline set in. A slight recovery in early January was superceded almost immediately by a pronounced fall on 10 January 1961. This was felt at all depths from the surface down to the 100 meter level. Although some recovery was recorded in the upper levels during the remainder of January and early February, the general trend at all depths was downward. Salinities throughout the entire water column ended up the period of observation in early March at considerably lower levels of value than were found in May of the previous year. Here again, the greatest change in salinity was observed in the waters above 200 meters depth.

A comparison of the variation of salinity values with depth under summer and winter conditions is presented in Figures 3 and 4. Both show a steady increase in salinity from surface to bottom, which is more accelerated in the upper waters and which has a markedly smaller range in the winter profile. The vertical range in winter (20 July 1960) was only 0.16 $^{o}/oo$ while in summer (10 January 1961) it amounted to 0.85 $^{o}/oo$.

The steady, although slight, increase observed in salinity values during the winter in the upper levels may be explained by an increase in salt content derived from the freezing out of the salt in new ice formation. Thickness of the ice at the icehole increased from 7 feet in April 1960 to 11 feet in October. Similarly, the sharp drop in salinity may be attributed to the cumulative build-up of both water and air temperatures which occurred during the latter half of December and which reached a high point in early January. Increased solar radiation also probably played a part. The consequent melting of some of the ice tended to dilute the upper waters and cause the drop in salinity noted. Lowering air temperatures during the remainder of January slowed down the melting process, and this is reflected in the slight salinity recovery during this period. A second high peak in minimum air temperatures occurred in early February and again sent salinities tumbling.

While there is evidence of current activity which may explain some of the salinity and other irregularities noted at depths of 50, 100, and 300 meters by the inflow of foreign water, there appears to be no possibility of the introduction of dilutants through run-off or surface melting. Situated at a distance of 2 miles from the nearest land and sealed in by ice cover during the entire period of observation, run-off is an impossibility, while puddling is a most rare phenomenon in the Antarctic.

C. Density

Since densities expressed as Sigma-t are derived from salinities, the graph showing their seasonal variation at various depths (Figure 7) is almost identical with the salinity distribution graph (Figure 6). Table 4 presents seasonal variations of density values. The approximate value of 2800 follows a rising curve, with some fluctuations, until it reached the surface on 7 November 1960. This value then follows a descending curve fluctuating from the surface early in December and continues to follow the general path of the salinity curve thereafter. Vertical distribution of Sigma-t in summer and winter in Figures 3 and 4, follows the salinity curve.

D. Sound Velocity

Table 5 presents seasonal variations of sound velocities[1] at different depth throughout the period of observation. The range is from 4710 to 4747ft/sec. At each level, there is very little change throughout the year; such microchanges as there are, are found in the upper waters. At each station, sound velocity shows a gradual and regular increase from surface to the bottom. There is no sound channel unless it is from the surface down to about 100 meters. The absence of a deep sound channel in the polar regions has been noted before. A review of sound velocities determined on some Hydrographic Office antarctic cruises (US Navy H. O. TR-48, 1956, TR-29, 1957, TR-33, 1956, and TR-82, 1961) shows comparable figures for the McMurdo Sound area. A slight sound channel was believed to exist at 10 meters at one station taken in McMurdo Sound in 1956. In other stations taken during DEEP FREEZE 60 in McMurdo Sound, there was some indication of a sound channel existing at depths of from 30 to 150 meters but the gradients were very slight. Further to the east, not too clearly marked sound channels were noted off the Bay of Whales at 100 meters depth and off Kainan Bay at between 50 and 100 meters. On DEEP FREEZE I, a section from Kainan Bay to Sulzberger Bay showed a sound channel between 50 and 200 meters depth. The 200 meters depth occurred at two deep stations off Kainan Bay where there was a minimum temperature layer. No sound channel was observed at stations taken off Cape Adare nor in Vincennes Bay in East Antarctica.[2]

[1] KUWAHARA, SUSUMU. Velocity of sound in sea water and calculation of the velocity for use in sonic soundings, Hydro Rev., vol. 16, no. 2, pp. 123-140, 1939.

[2] Authors Preference The Advisory Committee on Antarctic Names has under consideration the names, EAST ANTARCTICA and WEST ANTARCTICA.

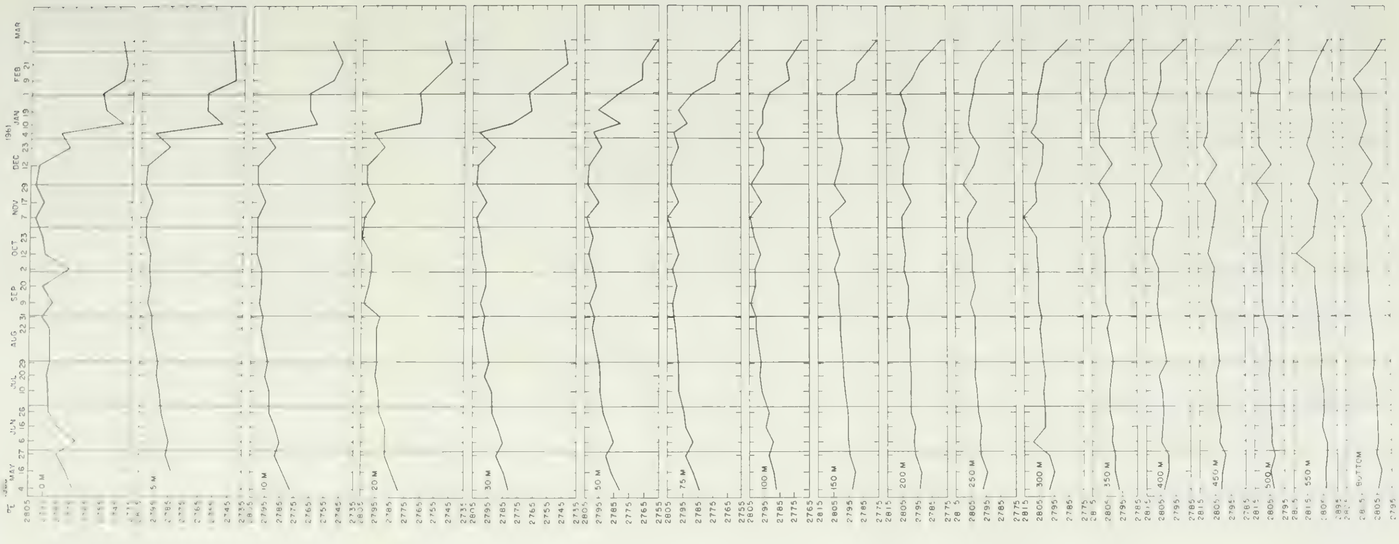

FIGURE 7. SEASONAL VARIATION OF DENSITY AT DEPTH AT THE ICEHOLE

TABLE 4. SEASONAL VARIATION OF DENSITY AT DEPTH AT THE ICEHOLE

DEPTH (M)	1960 MAY 4	16	27	JUNE 6	16	26	JULY 10	20	29	AUGUST 22	31	SEPTEMBER 9	20	OCTOBER 2	12	23	NOVEMBER 7	17	29	DECEMBER 12	23	1961 JANUARY 4	10	19	FEBRUARY 1	9	21	MARCH 7
0	2775	[illegible]	2786	2772	2766	2792	2792	2793	2791	2791	2796	2789	2797	2777	2795	2796	2801	2796	2800	2799	2775	2769	2740	2753	2756	2741	2739	2742
5	-	83	87	85	88	91	92	94	93	97	97	2800	98	99	98	2801	01	97	02	2801	86	96	50	60	60	41	42	43
10	78	83	88	85	88	92	92	95	93	98	97	99	98	98	2801	01	01	96	01	01	90	97	56	61	61	45	39	46
20	79	84	88	88	88	92	93	95	94	99	97	03	2800	98	98	04	03	96	02	01	90	97	65	64	65	51	39	44
30	81	84	89	85	88	92	92	97	94	98	97	99	96	96	98	99	02	96	02	01	90	2800	80	65	67	55	41	43
50	81	87	90	85	[illegible]	92	94	94	95	99	98	01	97	99	02	99	03	95	03	02	93	99	81	[illegible]	[illegible]	65	60	55
75	83	87	92	87	92	93	97	97	97	[illegible]	89	01	98	2801	97	00	05	97	02	02	97	00	91	97	87	73	71	60
100	87	[illegible]	92	89	94	92	97	98	97	2801	2801	04	01	02	98	02	05	97	04	96	96	00	96	[illegible]	91	79	80	[illegible]
150	[illegible]	[illegible]	[illegible]	95	96	96	98	99	99	01	01	[illegible]	02	05	01	05	08	97	05	01	[illegible]	02	2802	2803	2803	91	[illegible]	74
200	94	93	97	98	97	2800	2800	2800	2801	01	03	02	02	05	04	06	06	2800	06	05	2801	04	05	03	07	99	93	77
250	97	94	98	99	98	00	01	02	02	02	02	05	02	04	04	07	07	01	10	02	99	05	06	05	02	2801	96	83
300	98	99	98	2799	2801	01	02	01	02	04	03	05	05	05	06	06	15	06	07	02	01	07	06	05	04	02	2800	[illegible]
350	97	[illegible]	[illegible]	02	01	03	03	02	01	05	03	06	06	06	06	07	02	03	10	01	09	09	10	09	01	05	01	55
400	2803	[illegible]	[illegible]	05	04	03	04	06	01	05	06	07	06	06	10	09	04	03	11	03	08	10	06	09	05	03	03	[illegible]
450	02	01	99	03	02	04	04	05	03	05	05	08	07	06	10	08	05	04	12	03	12	09	09	09	[illegible]	06	01	06
500	[illegible]	04	01	03	03	04	[illegible]	05	04	06	08	09	09	09	10	10	08	04	12	02	10	10	10	10	10	[illegible]	09	[illegible]
550	03	03	02	02	05	04	04	06	05	07	07	08	09	09	22	10	08	06	12	[illegible]	13	10	09	[illegible]	10	10	[illegible]	97
Bottom	04	02	05	04	04	04	05	07	06	07	08	09	09	10	10	11	13	06	13	[illegible]	14	11	09	11	12	17	06	97

DENSITY (SIGMA-t)

TABLE 5. SEASONAL VARIATION OF SOUND VELOCITY AT DEPTH AT THE ICEHOLE

DEPTH	1960 MAY			JUNE			JULY			AUGUST		SEPTEMBER		OCTOBER			NOVEMBER			DECEMBER		1961 JANUARY			FEBRUARY			MARCH
(FT)	4	16	27	6	16	26	10	20	29	22	31	9	20	2	12	23	7	17	29	12	23	4	10	19	1	9	21	7
0	4713.4	4711.4	4718.5	4717.0	4714.9	4711.4	4715.1	4716.4	4717.4	4712.3	4712.2	4718.9	4711.8	4711.7	4718.3	4721.3	4711.9	4712.9	4715.8	4721.4	4711.9	4718.7	4714.8	4711.2	4710.6	4711.8	4713.7	4710.3
5	-	11.5	11.7	11.8	11.4	11.8	11.7	12.1	12.1	12.1	11.6	11.9	11.7	11.5	12.0	12.0	11.9	12.1	12.1	12.1	13.8	14.6	17.1	13.0	11.1	10.6	10.0	10.2
10	11.4	12.0	12.1	11.8	12.1	12.2	12.2	12.3	12.4	12.1	12.1	12.4	12.1	12.3	12.1	12.4	12.4	12.5	12.5	12.8	13.6	15.0	17.5	13.2	12.2	11.4	10.1	10.8
20	12.0	12.0	12.7	12.4	12.2	12.4	12.3	12.6	12.5	12.6	12.2	12.8	12.4	12.3	12.6	12.6	12.5	12.5	12.8	13.0	14.1	15.1	17.0	13.1	13.4	12.9	10.5	11.3
[illegible]	[illegible]	13.2	13.0	12.5	12.3	13.0	12.7	13.1	13.0	13.2	12.8	13.1	12.7	12.7	12.4	12.9	13.1	13.1	13.2	13.1	14.2	15.7	16.5	13.7	14.5	13.5	11.1	11.5
[illegible]	[illegible]	[illegible]	[illegible]	13.7	13.6	14.2	14.0	14.3	14.0	14.4	13.7	14.2	14.0	14.4	14.3	13.8	14.8	14.2	14.3	14.4	15.4	16.5	18.4	15.6	17.7	17.3	[illegible]	[illegible]
[illegible]	[illegible]	16.4	16.5	15.6	16.0	15.8	15.9	16.1	15.9	16.2	15.6	15.8	15.5	15.7	15.5	15.6	16.2	15.8	15.8	16.0	16.4	17.8	18.0	16.6	18.0	20.6	23.2	17.7
[illegible]	[illegible]	16.5	16.3	[illegible]	17.8	17.8	17.8	17.8	17.6	18.1	17.5	18.0	17.8	17.4	16.9	16.9	17.8	17.4	17.3	17.4	17.5	19.4	19.0	18.4	19.7	23.6	[illegible]	22.6
[illegible]	21.0	21.9	20.9	21.0	[illegible]	20.8	21.0	21.0	21.0	21.1	20.8	21.2	20.8	21.0	20.8	21.0	21.2	20.6	21.0	21.3	20.7	22.3	21.5	[illegible]	21.5	[illegible]	20.2	[illegible]
[illegible]	[illegible]	[illegible]	24.0	23.5	23.7	23.7	23.7	23.5	23.6	23.8	23.6	23.8	23.6	23.6	23.6	23.7	23.7	23.4	23.7	24.4	23.7	24.9	24.1	24.0	24.1	24.0	25.9	25.3
[illegible]	[illegible]	[illegible]	26.7	[illegible]	26.6	26.5	26.5	26.4	26.4	26.5	26.5	26.6	26.3	26.4	26.2	26.7	26.7	26.1	26.6	26.8	26.3	27.3	26.7	26.8	26.6	26.5	27.7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29.8	29.5	29.6	29.6	29.6	29.9	29.5	30.1	29.7	30.3	29.8	30.6	30.6	29.2	[illegible]	29.9	29.6	30.4	30.3	30.2	30.0	30.1	30.3	[illegible]
[illegible]	[illegible]	[illegible]	32.9	32.7	[illegible]	32.8	32.8	32.7	39.7	32.7	32.5	32.8	32.8	32.8	32.6	32.8	32.6	32.6	33.3	32.9	32.8	33.4	33.2	33.3	32.8	33.0	33.3	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.9	35.8	36.1	35.7	36.2	35.9	36.0	35.9	35.7	35.8	[illegible]	35.8	35.8	36.5	36.2	37.0	36.4	36.1	36.5	36.2	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.3	[illegible]	[illegible]	39.1	[illegible]	39.0	39.3	39.3	39.2	39.4	39.3	39.1	39.4	39.3	39.2	39.5	39.6	39.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	41.7	41.9	41.9	41.8	[illegible]	41.8	41.7	42.0	41.9	42.0	42.0	41.9	[illegible]	42.0	41.9	[illegible]	[illegible]	42.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42.3	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44.5	44.6	44.4	44.9	44.6	44.6	44.6	44.8	45.0	44.5	45.1	44.7	44.5	44.5	44.9	45.0	45.1	45.1	[illegible]	[illegible]	44.9	45.1	45.0	44.4
Bottom	45.9	46.2	45.7	45.4	45.1	45.4	45.3	45.6	45.4	45.3	45.5	45.7	45.7	46.0	46.4	46.1	46.7	46.4	46.9	46.4	47.4	46.9	47.0	46.9	[illegible]	47.3	[illegible]	[illegible]

NOTE: Sound Velocity from Kuwahara's Tables

SOUND VELOCITY (FT/SEC)

It has been found that the deep sound channel which is so prominent a feature in the waters of the equatorial and subtropical zones shallows to around 80 to 100 meters depth at the Antarctic Convergence and retains approximately this depth into the Antarctic. This also has been found to be true in the Arctic. A recent report (Kutschale, 1961) states that in the Arctic Basin the sound channel is from the surface down to about 350 meters. Sound velocity values were about the same order of magnitude as in the Antarctic (4750 feet per second in the sound channel and ranging from about 4690 to 4900 feet per second). In the Arctic, at least, this shallow sound channel is nevertheless effective, Kutschale reporting distances of 700 miles range.

E. Dissolved Oxygen

Table 6 presents seasonal variations of dissolved oxygen at depth at the icehole, throughout the period of observation, and these are portrayed graphically in Figure 8. Amounts range from 4.89 to 8.40 ml/l. There was little change in oxygen at all levels throughout the winter; a general dropping off of values occurred at all levels as the oxygen was slowly being used up without chance of much replenishment except by mass transfer of the water. In the lower levels of the water column, the change was very minor, even during the summer. By mid-December a decided rise in the values for dissolved oxygen above 100 meters depth commenced. Values reached a peak on 10 January, declined throughout the remainder of January and February and then started an increase. Termination of observations did not permit following up, unfortunately. The heavy crop of diatoms, which McMurdo Sound is known to have in late November and throughout the summer, is mainly responsible for oxygen increases, although some oxygen is undoubtedly brought in from other areas by currents. On many occasions when irregularities were noted in the oxygen profile, current measurements at these depths, made as soon afterward as possible, showed strong current activity. The depths at which these irregularities occurred were around 50, 100, 300, and 550 meters. The strongest currents observed were close to the bottom or at 550 meters and reach a value of 1.83 knots.

Figures 3 and 4 show vertical distribution of dissolved oxygen during summer and winter. In the summer curve, dissolved oxygen follows very closely the temperature curve and inversely that of salinity. In winter there is very little vertical variation in dissolved oxygen values.

Table 7 shows seasonal variation of percentage saturation of dissolved oxygen at depth at the icehole during the period of observation. At each station, higher percentages occurred near the surface and in the upper layers but at no time was the water completely

saturated. This is in marked contrast to the findings of the Australians at Mawson (Bunt, 1960) where saturated or supersaturated (as high as 171%) water was a common occurrence. Their stations were located in more northerly latitudes, were in considerably shallower water, and nearer shore. This may account for the difference in values. An examination of saturation of dissolved oxygen at other oceanographic stations (Table 8) in open waters of McMurdo Sound slightly farther north of the icehole station, reveals similar unsaturated water. The 26 January 1960 station values for oxygen saturation agree very closely with those obtained on 10 January 1961 at the icehole. Surface values for stations in the Ross Sea to the north of McMurdo Sound in much deeper water also show unsaturated water. Off the Ross Ice Shelf in the Little America area, the waters were supersaturated at the surface (up to 133%).

Variations in dissolved oxygen at the icehole station probably were caused by seasonal changes in the phytoplankton crop and from the introduction of foreign water by currents. During the latter part of November, McMurdo Sound's open waters develop a bloom of diatoms which makes the water taste fishy and, when concentrated in a plankton haul, smell like a newly opened can of raw oysters. This was not true at Wilkes Station in East Antarctica at a latitude near that of the Australian base at Mawson. As mentioned before (Tressler, 1960), this difference in the productivity of the two areas is believed to be due to the differences in the type of rock structure at the two places. At Wilkes Station, granitic rocks in the main apparently give off less nutrient material than the volcanic rocks at McMurdo. This was pointed out by Lisit͡syn in his report on Russian oceanographic observations off East Antarctica (Lisit͡syn, 1959). Why such a plentiful crop of phytoplankton as that produced at McMurdo should not cause supersaturation in the upper layers is a question. Strong current action in the northern half of McMurdo Sound may dissipate the amount of oxygen in the water and some may be lost to the atmosphere by wave action, high waves being the common state in this body of water. Also it is possible that larger micro-organisms may be in sufficient abundance to use up the oxygen. Whales are numerous in McMurdo Sound indicating the presence of abundant food. The Euphausidae or Krill are seen in large numbers on the undersides of upturned ice blocks. In the ice-covered water at the icehole station, currents alone probably could cause variations in the dissolved oxygen content. The rise noted in the last station (7 March 1961) came a day or so before a 2-day storm.

F. Conductivity and pH

Although these two parameters were not measured regularly, on one occasion each, determinations were made at different sampling depths.

TABLE 6. SEASONAL VARIATION OF DISSOLVED OXYGEN AT DEPTH AT THE ICEHOLE

DEPTH	1960 MAY			JUNE			JULY			AUGUST		SEPTEMBER		OCTOBER			NOVEMBER			DECEMBER		1961 JANUARY			FEBRUARY			MARCH
[illegible]	4	16	27	6	16	26	10	20	29	22	31	9	20	2	12	23	7	[illegible]	[illegible]	12	[illegible]	4	[illegible]	19	1	[illegible]	21	[illegible]
[illegible]	[illegible]	6.23	[illegible]	[illegible]	6.33	6.20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.62	5.18	[illegible]	5.76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	6.42	[illegible]	[illegible]	6.45	6.37	[illegible]	[illegible]	[illegible]	6.21	6.16	[illegible]	[illegible]	[illegible]	5.91	[illegible]	[illegible]	5.68	[illegible]	[illegible]	[illegible]	6.23	[illegible]	[illegible]	7.43	7.24	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	6.36	[illegible]	[illegible]	[illegible]	[illegible]	6.15	[illegible]	[illegible]	5.87	[illegible]	[illegible]	[illegible]	5.77	5.91	[illegible]	[illegible]	6.30	6.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	6.07	[illegible]	6.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.36	[illegible]	[illegible]	[illegible]	[illegible]	7.27	[illegible]
[illegible]	[illegible]	6.17	6.10	6.46	[illegible]	[illegible]	6.23	[illegible]	[illegible]	6.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.63	[illegible]	[illegible]	6.36	7.02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.67	[illegible]	[illegible]	[illegible]	6.01	[illegible]	6.95	[illegible]	[illegible]	–	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6.23	[illegible]	[illegible]	6.16	[illegible]	[illegible]	[illegible]	5.67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.15	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.83	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.51
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.86	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]													
[illegible]															[illegible]	5.88	[illegible]	6.01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DISSOLVED OXYGEN (ml/l)

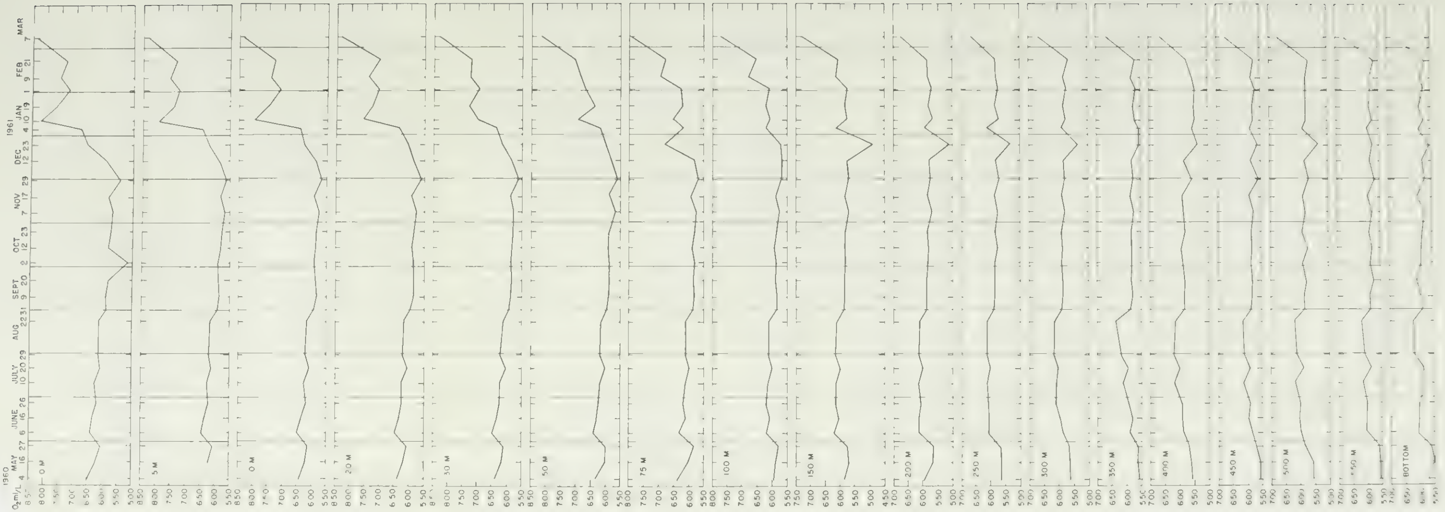

FIGURE 8. SEASONAL VARIATION OF DISSOLVED OXYGEN AT DEPTH AT THE ICEHOLE

TABLE 7. SEASONAL VARIATION OF PERCENT SATURATION OF DISSOLVED OXYGEN AT DEPTH AT THE ICEHOLE

DEPTH (M)	1960 MAY			JUNE			JULY			AUGUST		SEPTEMBER		OCTOBER			NOVEMBER			DECEMBER		1961 JANUARY			FEBRUARY			MARCH
	4	16	27	6	16	26	10	20	29	22	31	9	20	2	12	23	7	17	29	12	23	4	10	19	1	9	21	7
0	77	74	73	76	75	73	75	72	73	73	70	71	69	61	62	69	67	68	65	71	70	62	87	90	85	89	86	96
5	76	74	72	76	75	73	74	72	73	73	70	[illegible]	70	62	62	68	67	69	66	69	74	77	94	88	85	[illegible]	86	[illegible]
10	75	73	72	76	75	73	74	72	73	73	70	[illegible]	69	63	62	69	68	70	67	70	75	76	95	68	84	[illegible]	86	[illegible]
20	75	73	72	75	75	74	74	71	73	73	70	69	69	62	62	69	68	70	66	69	71	75	90	[illegible]	[illegible]	87	85	99
30	76	73	72	76	75	74	74	71	73	72	70	69	69	62	62	68	68	69	66	69	73	75	[illegible]	86	82	86	85	96
50	75	71	71	76	74	74	73	71	73	73	70	70	69	62	62	69	67	69	66	68	71	73	83	85	80	84	83	98
75	76	71	[illegible]	75	72	73	72	71	72	72	69	69	69	61	62	69	68	70	67	69	69	73	[illegible]	83	74	83	81	95
100	71	70	69	74	72	74	73	71	72	72	69	69	70	62	63	69	68	69	67	67	64	73	73	83	72	81	78	92
150	71	69	68	74	72	73	73	71	73	72	69	69	69	61	62	69	67	69	67	68	58	72	[illegible]	69	68	73	72	[illegible]
200	70	67	67	72	73	72	73	71	73	72	[illegible]	[illegible]	69	61	61	69	67	69	68	[illegible]	[illegible]	70	67	69	80	[illegible]	74	81
250	67	67	67	72	72	72	72	71	72	72	69	69	69	61	62	69	68	69	67	68	63	70	[illegible]	[illegible]	68	[illegible]	[illegible]	[illegible]
300	66	66	67	69	70	72	72	71	73	72	69	69	69	62	62	70	69	69	68	68	63	69	[illegible]	69	67	[illegible]	67	[illegible]
350	66	66	67	70	64	70	72	70	73	81	70	68	69	61	61	69	68	64	68	68	66	69	[illegible]	[illegible]	67	[illegible]	67	[illegible]
400	66	66	66	69	[illegible]	[illegible]	73	71	73	72	69	64	69	62	62	68	69	69	66	69	64	68	[illegible]	[illegible]	67	[illegible]	67	[illegible]
450	66	66	66	69	71	70	72	70	72	73	69	64	69	62	62	69	68	70	66	69	66	69	67	[illegible]	67	[illegible]	68	[illegible]
500	66	66	68	71	71	7	73	70	72	73	69	69	68	62	61	70	64	69	67	69	63	70	[illegible]	[illegible]	[illegible]	68	67	79
550	66	66	67	72	71	71	73	69	72	73	69	70	68	62	62	70	69	70	68	69	68	70	68	[illegible]	69	[illegible]	67	79
Bottom	[illegible]	68	67	72	71	71	70	69	73	73	69	70	69	63	61	70	70	70	68	69	66	70	68	[illegible]	[illegible]	69	67	[illegible]

TABLE 8. PERCENTAGE SATURATION OF DISSOLVED OXYGEN IN MCMURDO SOUND AND OTHER AREAS IN THE ROSS SEA

26 January 1960

LATITUDE 77°42'S LONGITUDE 166°10'E												
DEPTH (M)	0	10	20	30	50	75	100	125	150	200	250	300
SATURATION (%)	96	98	94	88	85	80	78	78	78	78	78	78

January 1960

LATITUDE	69° 03' S	70° 02' S	68° 00' S	71° 13' S	72° 00' S	78° 10' S	77° 44' S	77° 26' S	77° 34' S
LONGITUDE	179° 06' E	179° 10' E	179° 55' E	179° 10' E	179° 10' E	161° 56' W	162° 12' W	169° 30' E	166° 02' E
DEPTH (M)	3500	3600	1800	2500	2000	650	200	289	293
SATURATION (%)	90	86	91	92	93	133	133	117	121

Conductivity on 22 August ranged from 76,000 to 80,000 micromhos/cm^3; the lowest reading was at 500 meters, and the higher readings at various depths (0, 10, 100, and 300 meters). Values of pH were determined on 9 February 1961; the results ranged from a high of 8.17 at 10 meters to 7.72 at 250 meters. There was no apparent order of vertical progression in either conductivity or pH values. At Mawson, the pH range was somewhat greater (6.87 to 8.86), pH tending to increase slightly with depth. The opposite was noted at McMurdo.

G. Transparency

Transparencies were taken with a white Secchi disc under the two lights over the "A" frame. Transparency ranged from 10 to 16 meters under these conditions. Unfortunately, the water became fouled by rust from the metal liner of the hole and for this reason transparency readings had to be discontinued. The water in McMurdo Sound often shows a high degree of transparency at times when diatom growth is not excessive. In early November 1956, a transparency reading of 47 meters was observed in McMurdo Sound. A month later this had been reduced to 5 meters by the spring diatom crop. (U. S. Navy Hydrographic Office TR-33).

H. Currents

The results of current measurements made at the icehole from May through December 1960, are shown in Table 9, and the majority of current stations are shown graphically in Figures 9 through 24. Blank spaces occurring in the table, show either malfunction of the current meter or slack water, although the current meter was brand new and seemed to be functioning very well most of the time. On 15 July 1960, for example, the meter appeared to function perfectly in the air and just below the surface, so slack water was probably the cause of no current.

In Table 9, times are local and indicate the commencement of the reading; the duration of current measurement was usually 10 minutes. In Figures 9 through 24 mid-current time is plotted. Table 10 shows the phases and positions of the moon throughout the year. Reference to this table will show the state of the tide at any given day. Tidal indications have been made on some of the figures. Of the 271 current measurements made at the icehole for which direction was obtained, 142 observations had an easterly and 129 a westerly set. A further breakdown shows the set of all currents (including all depths) to be in the following sectors: 44% 0^{o} to 90^{o} sector, 30% in the 270^{o} to 360^{o} sector, 15% between 180^{o} and 270^{o}, and 11% between 90^{o} and 180^{o}. Except for one measurement all currents below 300 meters depth set between 0^{o} and 95^{o} (average set of 70^{o} true). This is shown in Figure 21 where the set of the current at 562 meters varied only 15^{o}

TABLE 9. CURRENT OBSERVED AT THE ICEHOLE

(Sta. 1) 15 May 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	[illegible]	167	0.16
[illegible]	[illegible]	195	0.15
[illegible]	[illegible]	275	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	147	0.30
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	76	0.36
[illegible]	[illegible]	75	0.07
[illegible]	[illegible]	58	0.34
	[illegible]	(on bottom)	

(Sta. 2) 2[illegible] May 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1111	565	[illegible]	0.1[illegible]
1145	500	-	-
1215	500	[illegible]3	0.24
1232	300	2[illegible]0	0.15
1[illegible]7	2[illegible]	1[illegible]7	0.18
[illegible]7	100	2[illegible]	0.11
1355	50	261	0.31
1409	10	265	0.41

(Sta. 3) 31 May 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1[illegible]	4	-	-
1341	4	2[illegible]	0.14
[illegible]	10	[illegible]3	0.[illegible]1
13[illegible]	20	[illegible]5	0.13
[illegible]	30	2[illegible]1	0.39
[illegible]	50	18	0.15

(Sta. 4) 1 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1428	4	321	0.18
1443	30	315	0.33
1459	50	325	0.24
1516	75	315	0.29
1533	100	328	0.21

(Sta. 5) 2 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1517	4	175	0.06
1533	10	-	-
[illegible]	10	292	[illegible]
1602	20	302	0.14

(Sta. 6) 3 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1113	4	-	-
1126	10	-	-
1144	4	-	-
12[illegible]	20	-	-
1246	10	-	-
[illegible]	20	110	0.06
1336	20	-	-
13[illegible]1	3[illegible]	[illegible]	0.03
1427	50	-	-
14[illegible]	10	-	-
1[illegible]	4	-	-

(Sta. 7) 7 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
14[illegible]	4	[illegible]	0.[illegible]5
14[illegible]	50	15	0.[illegible]
14[illegible]7	40	-	-
14[illegible]5	30	3[illegible]	[illegible]
1458	20	3[illegible]	0.12
1511	10	15	0.1[illegible]
15[illegible]5	[illegible]	[illegible]	0.13
[illegible]	25	[illegible]	0.1[illegible]
15[illegible]			

(Sta. 8) 5 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1047	4	35	0.12
1125	4	85	0.10
1205	4	355	0.06
1433	4	285	0.13
1524	4	265	0.19
1100	10	52	0.13
1137	10	42	0.12
1219	10	25	0.10
1455	10	284	0.19
1537	10	275	0.24
1113	20	45	0.10
1150	20	35	0.07
1510	20	276	0.24
1551	20	275	0.27

(Sta. 9) 10 June 1960

TIME (Local)	DEPTH (Meter)	SET (° True)	DRIFT (Knots)
1428	4	282	0.18
1442	4	272	0.16
1456	4	265	0.21
1510	4	306	0.25
1523	4	265	0.22

(Sta. 10) 14 June 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1113	4	1[illegible]0	0.33
1208	4	117	0.30
1415	4	75	0.21
1536	4	-	-
1125	30	92	0.47
1234	30	[illegible]	0.36
14[illegible]	30	[illegible]	0.27
1555	30	[illegible]	[illegible]
[illegible]	50	75	[illegible]
1155	50	73	[illegible]
14[illegible]	50	85	[illegible]
1611	50	52	[illegible]
1153	75	67	[illegible]
13[illegible]9	75	75	[illegible]
14[illegible]	75	116	[illegible]
1532	75	74	[illegible]

(Sta. 11) 15 June 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1047	[illegible]	[illegible]	[illegible]
1225	[illegible]	-	-
14[illegible]	[illegible]	[illegible]	[illegible]
11[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-	[illegible]
[illegible]	[illegible]	-	[illegible]
[illegible]	[illegible]	-	[illegible]
1329	[illegible]	-	-
			-

(Sta. 12) 21 June 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1035	5	227	0.21
1209	5	148	0.24
1304	5	232	0.17
1348	5	62	0.33
1056	350	66	0.75
1238	350	67	0.38

(Sta. 13) 13 July 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1033		-	-
1047	[illegible]	[illegible]	[illegible]
1100	[illegible]	[illegible]	[illegible]
1113	[illegible]	[illegible]	[illegible]
1128	[illegible]	[illegible]	[illegible]
1141	[illegible]	[illegible]	[illegible]
1214	[illegible]	[illegible]	[illegible]
1227	[illegible]	-	[illegible]
1240	[illegible]	[illegible]	[illegible]
1252	[illegible]	[illegible]	[illegible]
1306	[illegible]	[illegible]	[illegible]
1318	[illegible]	[illegible]	[illegible]
1330	[illegible]	[illegible]	[illegible]
1343	[illegible]	[illegible]	[illegible]
1355	[illegible]	[illegible]	[illegible]
1407	[illegible]	-	-
1419	[illegible]	[illegible]	[illegible]
1432	[illegible]	[illegible]	[illegible]
1444	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1	[illegible]	[illegible]
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	350	0.08
[illegible]	1[illegible]	352	0.14

(Sta. 14) 15 July 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	3	-	-
[illegible]	4	[illegible]	-
[illegible]	5	-	-
[illegible]	6	-	-
[illegible]	7	-	-
[illegible]	8	-	-
[illegible]	9	[illegible]	[illegible]
[illegible]	[illegible]0	[illegible]	[illegible]
[illegible]	3	-	-
[illegible]	4	[illegible]	[illegible]
[illegible]	5	-	-
[illegible]	7	-	-

(Sta. 15) 15 July 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1402	3	-	-
1415	4	275	[illegible]
1429	5	277	[illegible]
1442	6	275	[illegible]
1455	7	265	[illegible]
1511	8	285	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

(Sta. 16) 29 July 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.18
[illegible]	[illegible]	[illegible]	0.23
[illegible]	[illegible]	[illegible]	0.15
[illegible]	[illegible]	[illegible]	0.16
[illegible]	[illegible]	[illegible]	0.18
[illegible]	[illegible]	[illegible]	0.25
[illegible]	[illegible]	[illegible]	0.25
[illegible]	[illegible]	[illegible]	0.09

(Sta. 17) 2 August 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1013	[illegible]	[illegible]	-
1025	[illegible]	[illegible]	[illegible]
1036	[illegible]	[illegible]	[illegible]
1048	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.06
[illegible]	[illegible]	-	.13
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.1
[illegible]	[illegible]	[illegible]	0.2
[illegible]	[illegible]	[illegible]	0.1
[illegible]	[illegible]	[illegible]	0.2

(Sta. 18) 9 August 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	[illegible]6
[illegible]	[illegible]	[illegible]	[illegible]6
[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.[illegible]1
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible]	[illegible]	-	-

(Sta. 19) 10 August 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1209	500	43	0.60
1253	500	81	0.65
1335	500	86	0.59
14[illegible]	500	8[illegible]	0.53

(Sta. 20) 7 September 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	[illegible]	[illegible]	[illegible]

(Sta. 21) 15 September 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	[illegible]	[illegible]	0.30
[illegible]	[illegible]	[illegible]	0.27
[illegible]	[illegible]	[illegible]	0.25
[illegible]	[illegible]	[illegible]	0.26
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.29
[illegible]	[illegible]	[illegible]	0.3[illegible]
[illegible]	[illegible]	[illegible]	0.30
[illegible]	[illegible]	[illegible]	0.28
[illegible]	[illegible]	[illegible]	[illegible]1
[illegible]	[illegible]	[illegible]	0.15
[illegible]	[illegible]	[illegible]	0.15
[illegible]	[illegible]	[illegible]	0.11
[illegible]	[illegible]	[illegible]	0.16
[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	0.17
[illegible]	[illegible]	[illegible]	0.16
[illegible]	[illegible]	[illegible]	0.15
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.19

(Sta. 22) 16 September 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1459	502	69	0.56
1441	5[illegible]2	75	0.58
1322	5[illegible]2	75	0.55
14[illegible]4	5[illegible]	77	0.57
1441	5[illegible]2	79	0.49
1520	512	[illegible]4	0.48
1550	512	82	0.48

(Sta. 23) 15 October 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
10[illegible]3	[illegible]	[illegible]	-
1137	[illegible]	[illegible]	-
1224	[illegible]	[illegible]	[illegible]
13[illegible]	[illegible]	-	-
[illegible]	[illegible]	-	[illegible]
15[illegible]4	[illegible]	-	-
155[illegible]	[illegible]	[illegible]	-

17 December 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	[illegible]	[illegible]
[illegible]	30	-	[illegible]
[illegible]	30	[illegible]	[illegible]

(Sta. 25) 28 December 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	DRIFT (Knots)
1017	[illegible]	[illegible]	[illegible]
1109	[illegible]	[illegible]	[illegible]
1210	[illegible]	[illegible]	[illegible]
1258	[illegible]	[illegible]	[illegible]
1348	[illegible]	[illegible]	[illegible]
1[illegible]22	[illegible]	[illegible]	[illegible]
1[illegible]40	[illegible]	[illegible]	[illegible]
11[illegible]	[illegible]	[illegible]	[illegible]
12[illegible]	[illegible]	[illegible]	[illegible]
1319	[illegible]	[illegible]	[illegible]
1414	[illegible]	[illegible]	[illegible]

(Sta. 26) 30 December 1960

TIME (Local)	DEPTH (Meters)	SET (° True)	[illegible]
1004	20	[illegible]	[illegible]
1047	[illegible]	[illegible]	[illegible]
1133	[illegible]	[illegible]	[illegible]
1244	[illegible]	[illegible]	[illegible]

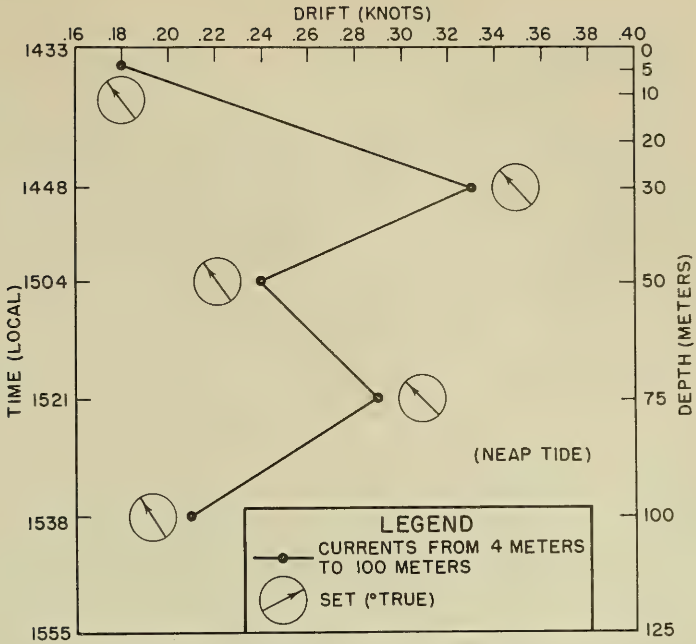

FIGURE 9. CURRENT STATION 4, 1 JUNE 1960

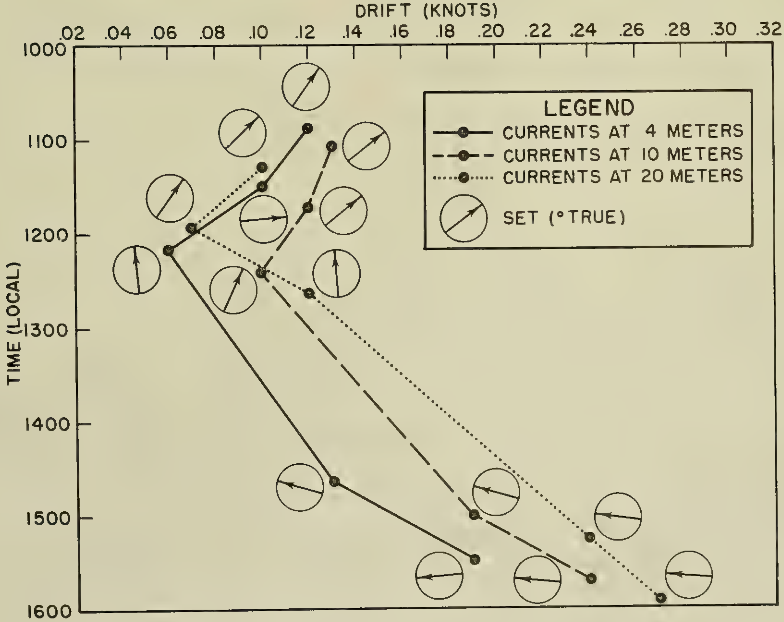

FIGURE 10. CURRENT STATION 8, 9 JUNE 1960

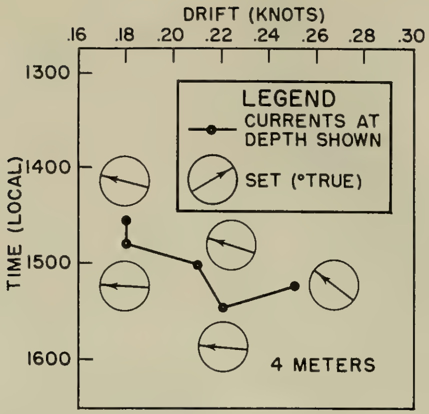

FIGURE 11. CURRENT STATION 9, 10 JUNE 1960

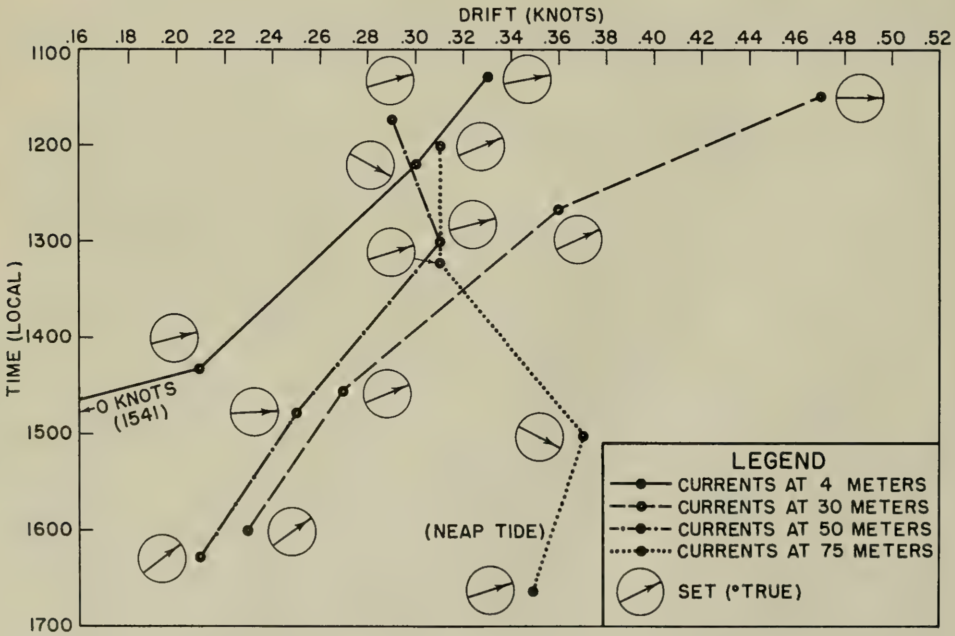

FIGURE 12. CURRENT STATION 10, 14 JUNE 1960

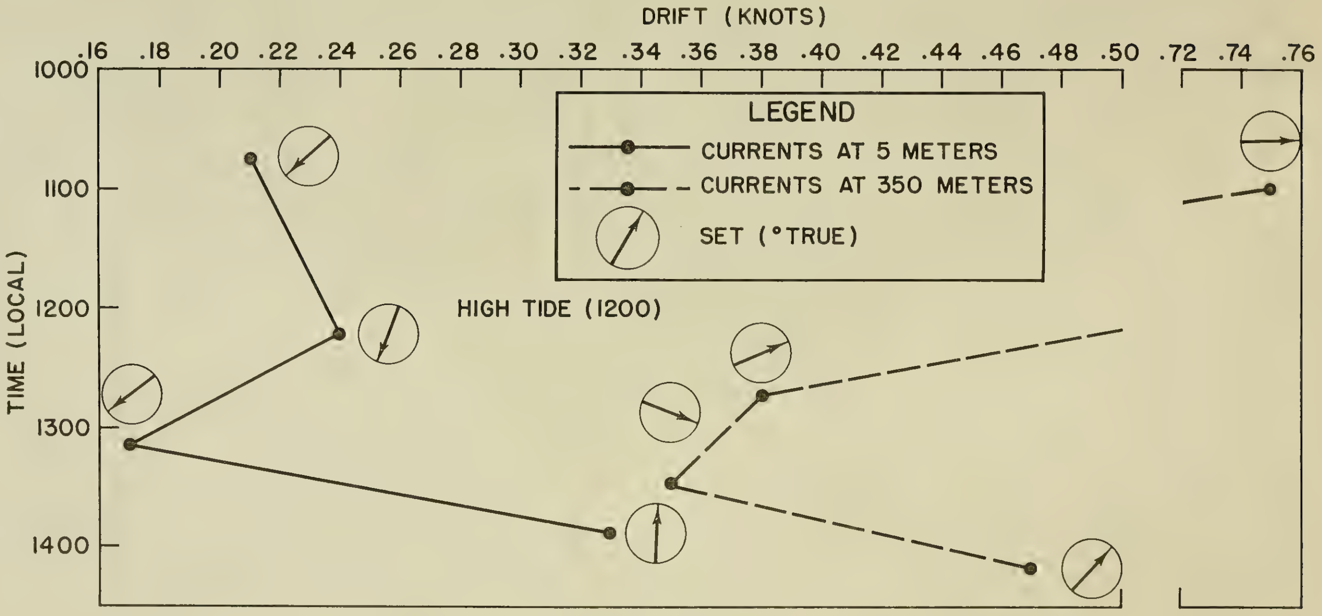

FIGURE 13. CURRENT STATION 12, 21 JUNE 1960

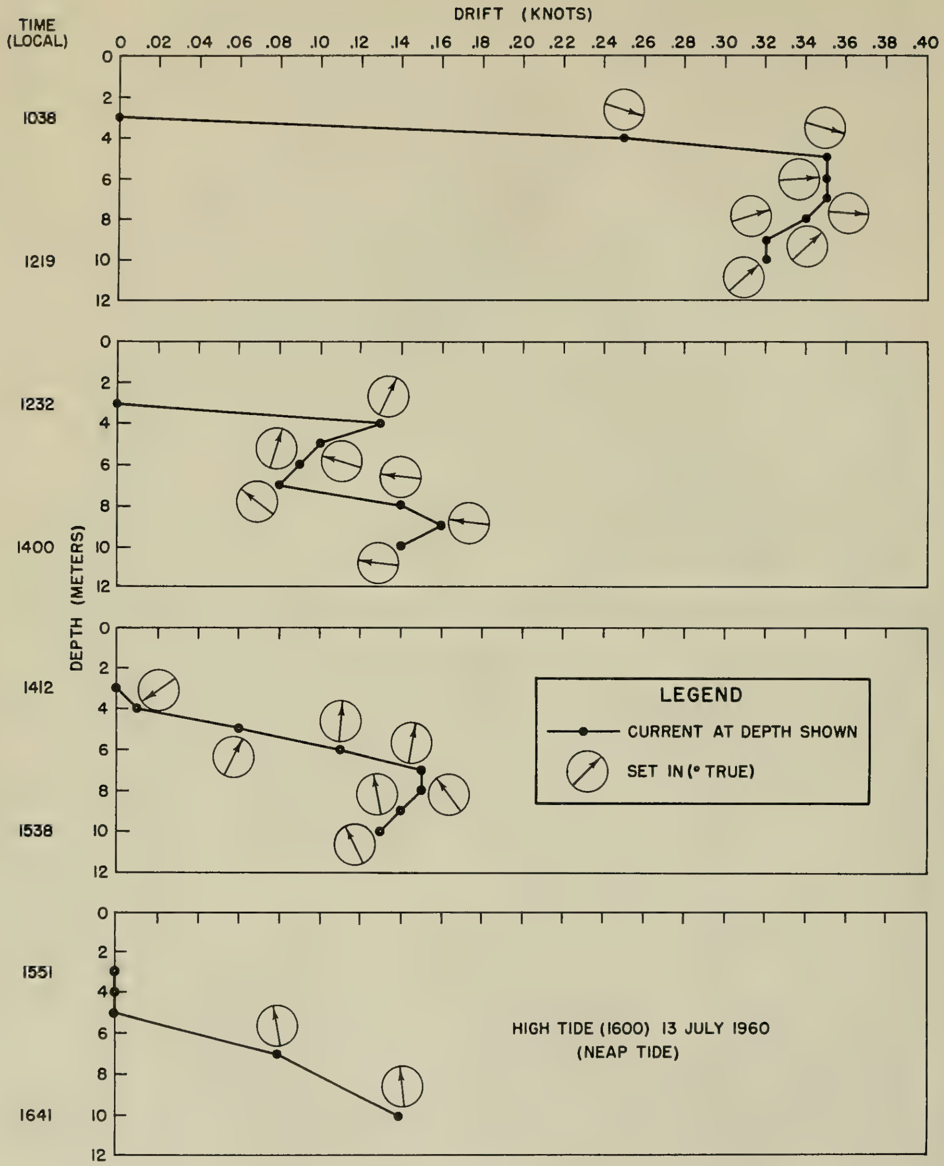

FIGURE 14. CURRENT STATION 13, 13 JULY 1960

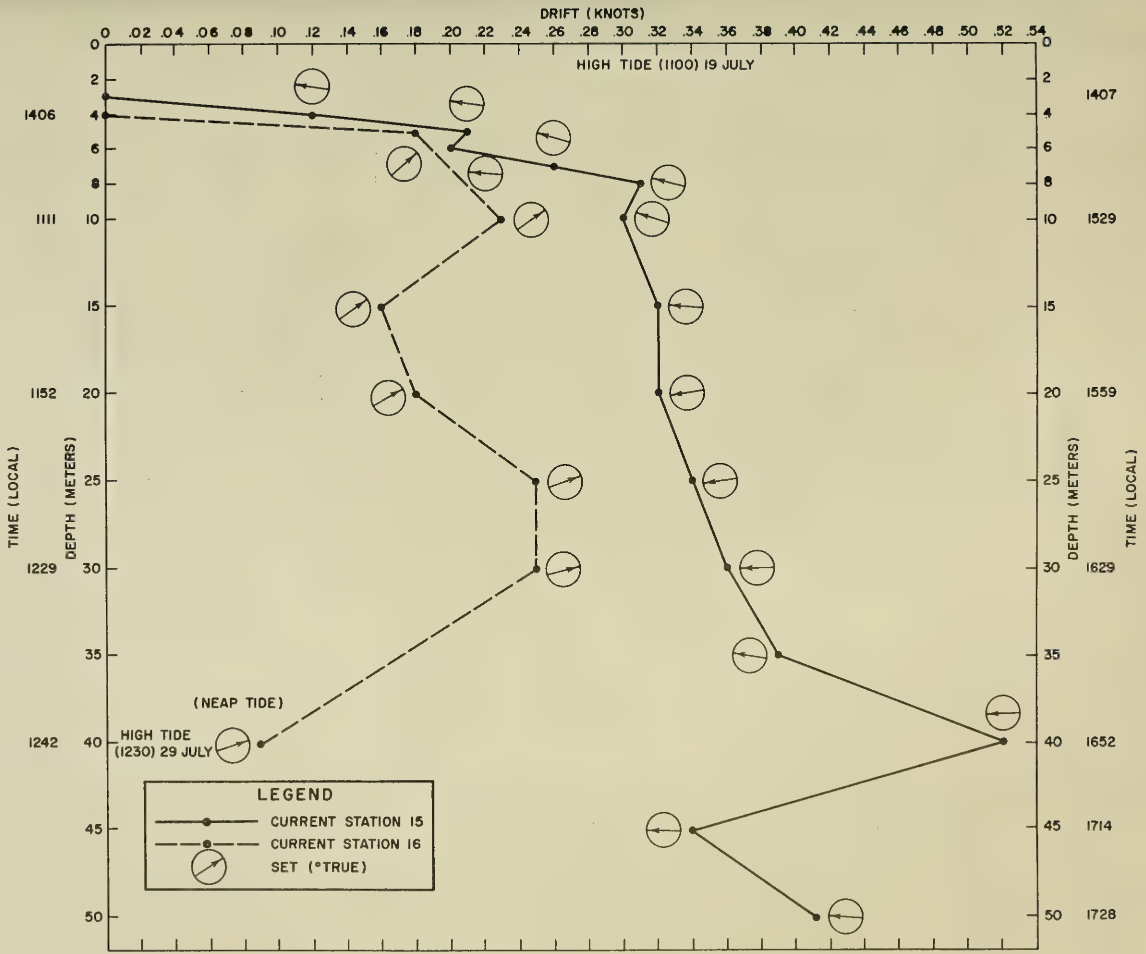

FIGURE 15. CURRENT STATIONS 15 AND 16, 19 AND 29 JULY 1960

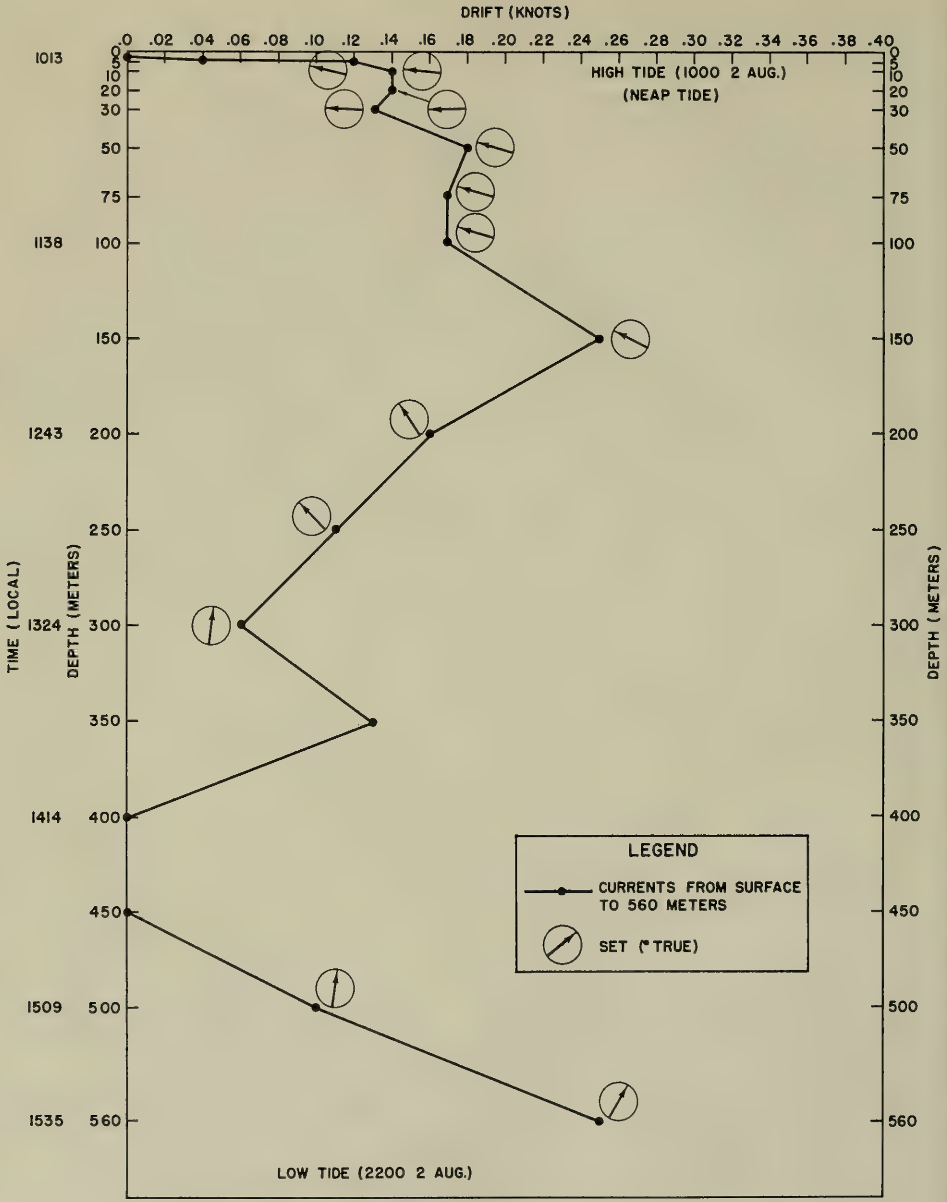

FIGURE 16. CURRENT STATION 17, 2 AUGUST 1960

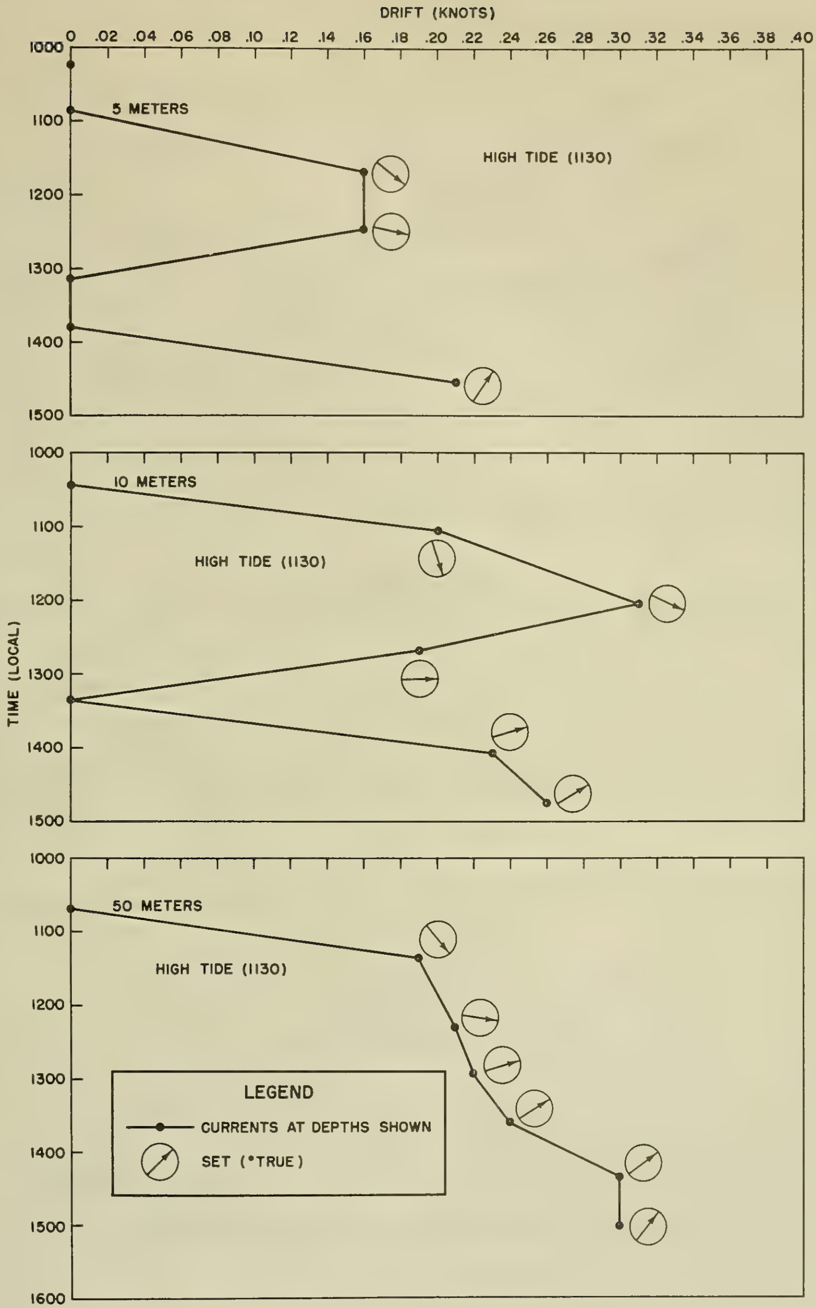

FIGURE 17. CURRENT STATION 18, 9 AUGUST 1960

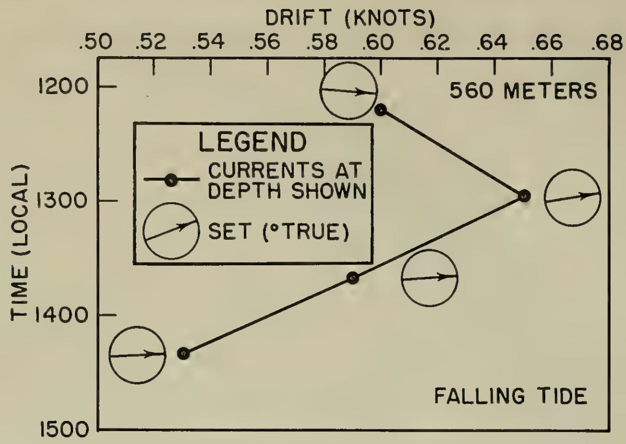

FIGURE 18. CURRENT STATION 19, 10 AUGUST 1960

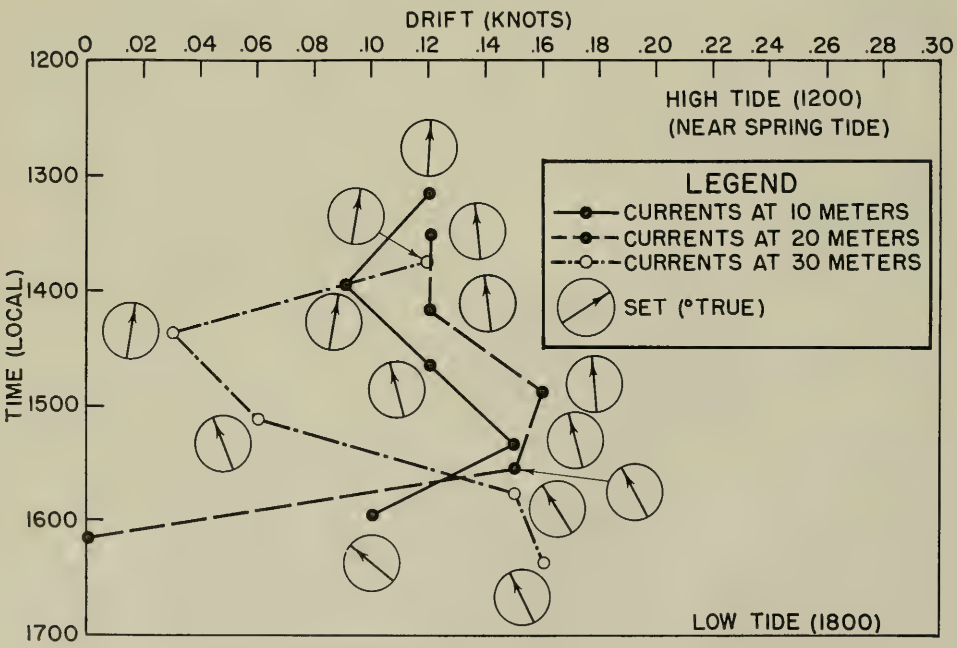

FIGURE 19. CURRENT STATION 20, 7 SEPTEMBER 1960

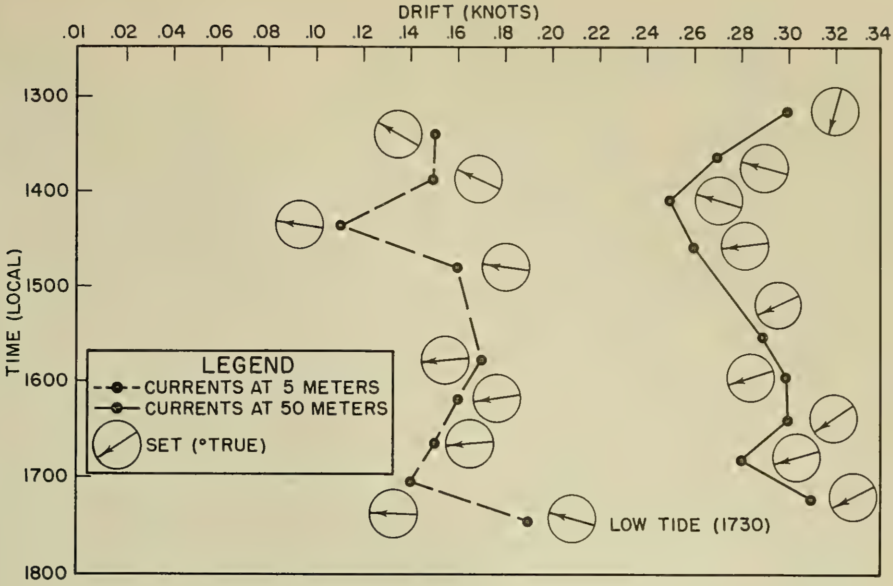

FIGURE 20. CURRENT STATION 21, 15 SEPTEMBER 1960

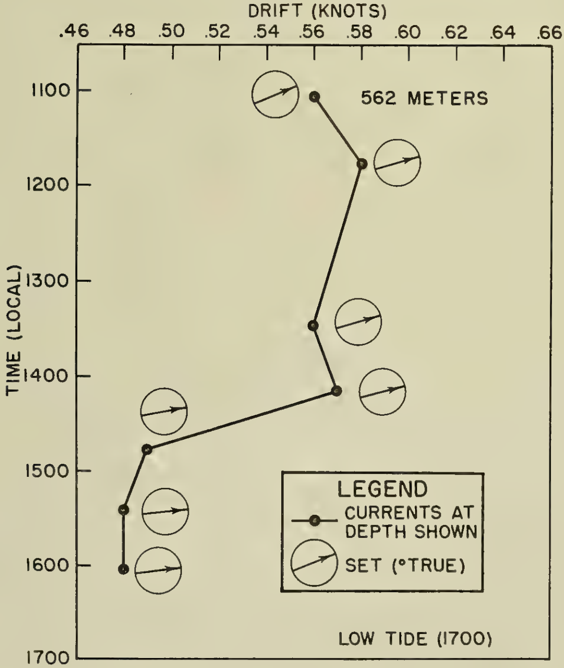

FIGURE 21. CURRENT STATION 22, 16 SEPTEMBER 1960

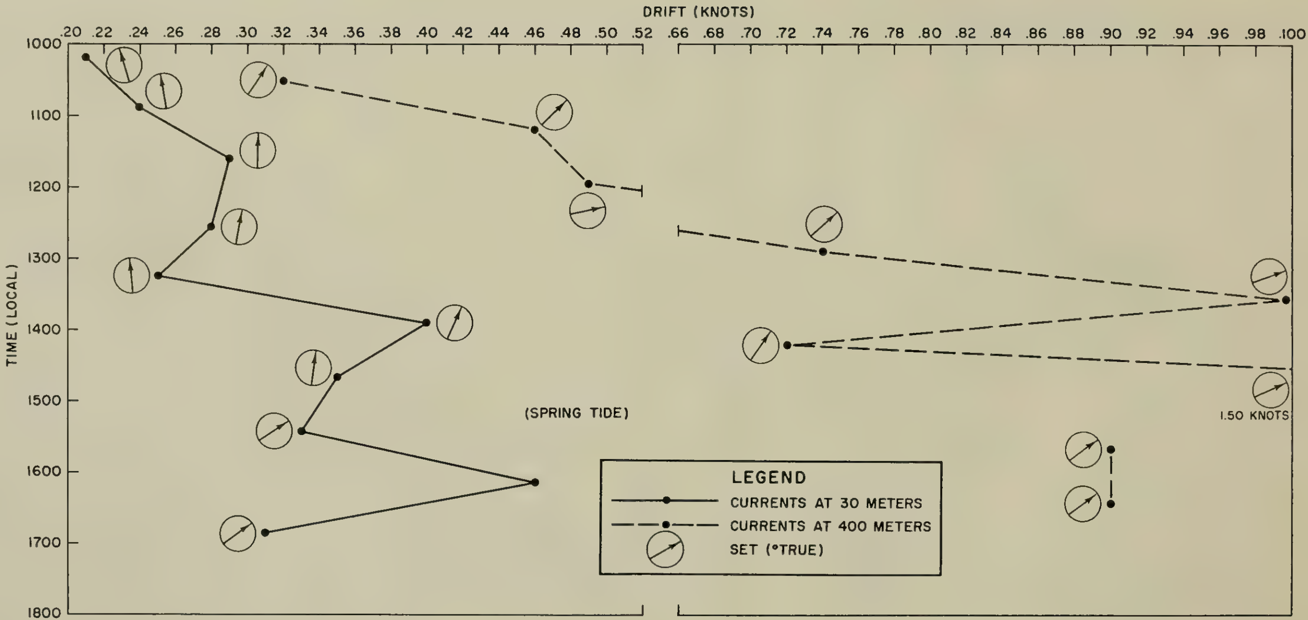

FIGURE 22. CURRENT STATION 24, 17 DECEMBER 1960

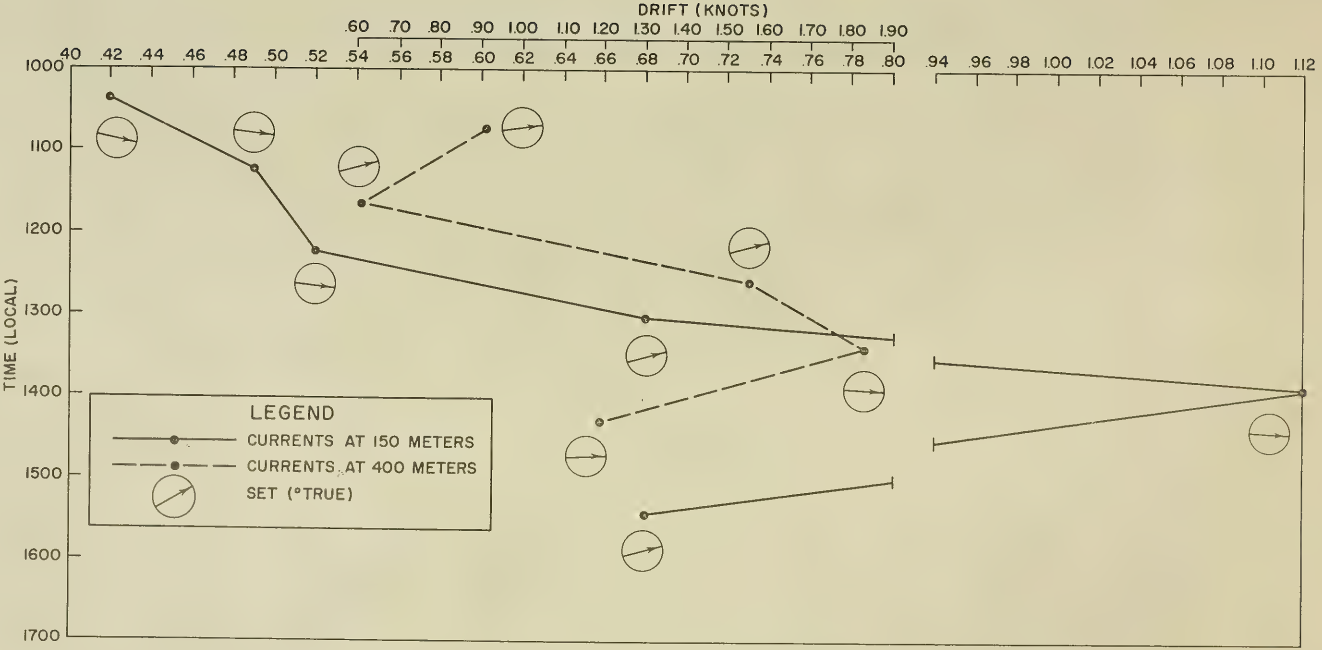

FIGURE 23. CURRENT STATION 25, 28 DECEMBER 1960

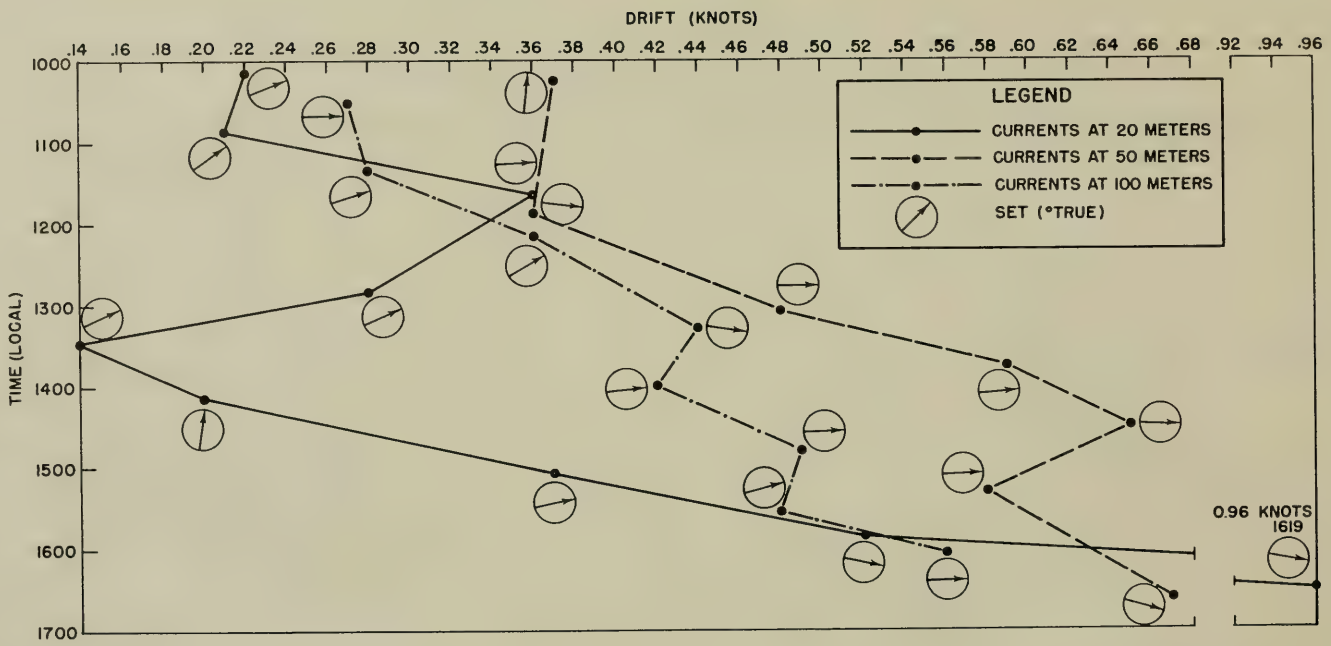

FIGURE 24. CURRENT STATION 26, 30 DECEMBER 1960

TABLE 10. ASTRONOMICAL DATA, 1960

Greenwich mean time of the moon's phases, apogee, perigee, greatest north and south declination, moon on the Equator, and the solar equinoxes and solstices.

January

	d.	h.	m.
E	4	16	..
☽	5	18	53
A	10	13	..
N	12	4	..
○	13	23	51
E	19	10	..
☾	21	15	01
S	25	20	..
P	26	10	..
●	28	6	16

February

	d.	h.	m.
E	1	3	..
☽	4	14	27
A	7	6	..
N	8	12	..
○	12	17	24
E	15	16	..
☾	19	23	48
S	22	4	..
P	23	3	..
●	26	18	24
E	28	13	..

March

	d.	h.	m.
☽	5	11	06
A	6	2	..
N	6	21	..
○	13	8	26
E	14	0	..
P	19	7	..
☾	20	6	41
S	20	10	..
$\odot_1$	20	14	43
E	26	22	..
●	27	7	38

April

	d.	h.	m.
A	2	22	..
N	3	5	..
☽	4	7	05
E	10	9	..
○	11	20	28
P	14	19	..
S	16	16	..
☾	18	12	57
E	23	5	..
●	25	21	45
N	30	13	..
A	30	16	..

May

	d.	h.	m.
☽	4	1	01
E	7	20	..
○	11	5	43
P	12	18	..
S	14	0	..
☾	17	19	55
E	20	12	..
●	25	12	27
N	27	21	..
A	28	4	..

June

	d.	h.	m.
☽	2	16	02
E	4	6	..
○	9	13	02
P	10	2	..
S	10	11	..
☾	16	4	36
E	16	19	..
$\odot_2$	21	9	43
●	24	3	27
N	24	4	..
A	24	10	..

July

	d.	h.	m.
E	1	15	..
☽	2	3	49
S	7	23	..
P	8	11	..
○	8	19	37
E	14	3	..
☾	15	15	43
N	21	11	..
A	21	14	..
●	23	18	31
E	28	21	..
☽	31	12	39

August

	d.	h.	m.
S	4	10	..
P	5	20	..
○	7	2	41
E	10	13	..
☾	14	5	37
N	17	19	..
A	18	1	..
●	22	9	16
E	25	3	..
☽	29	19	23
S	31	18	..

September

	d.	h.	m.
P	2	21	..
○	5	11	19
E	6	23	..
☾	12	22	20
N	14	2	..
A	14	18	..
●	20	23	13
E	21	10	..
$\odot_3$	23	1	00
S	28	0	..
☽	28	1	13
P	29	22	..

October

	d.	h.	m.
E	4	8	..
○	4	22	17
N	11	10	..
A	12	13	..
☾	12	17	26
E	18	19	..
●	20	12	03
P	24	20	..
S	25	5	..
☽	27	7	34
E	31	16	..

November

	d.	h.	m.
○	3	11	58
N	7	19	..
A	9	9	..
☾	11	13	48
E	15	5	..
●	18	23	47
P	21	4	..
S	21	13	..
☽	25	15	42
E	27	23	..

December

	d.	h.	m.
○	3	4	25
N	5	4	..
A	7	3	..
☾	11	9	39
E	12	16	..
●	18	10	47
S	19	1	..
P	19	11	..
$\odot_4$	21	20	27
☽	25	2	30
E	25	6	..

●, new moon; ☽, first quarter; ○, full moon; ☾, last quarter; E, moon on the Equator; N, S, moon farthest north or south of the Equator; A, P, moon in apogee or perigee; $\odot_1$, sun at vernal equinox; $\odot_2$, sun at summer solstice; $\odot_3$, sun at autumnal equinox; $\odot_4$, sun at winter solstice.

0^h is midnight. 12^h is noon. The times may be adapted to any other time meridian than Greenwich by adding the longitude in time when it is east and subtracting it when west. (15° of longitude equals 1 hour of time).

This table was compiled from the American Ephemeris and Nautical Almanac.

over a period of 5 hours, the general direction of set being a little north of east. Figure 18, also illustrates this point. In the upper waters, however, the general direction of set was to the northwest and west as shown in figures 9, 11, 13, 15, 19, and 20. In Figure 22, a contrast of current direction is shown at depths of 30 and 400 meters. Exceptions to the general rule of currents setting to the west and northwest in the upper levels occurred on 14 June 1960 (Fig. 13) and at the last two stations measured on 28 and 30 December 1960 (Figs. 24 and 25).

The currents observed at the icehole appeared to be tidal in origin or were at least influenced by the tide. This is shown in Figures 12, 16, 18, 19, and 24. Drift ranged from 0.01 knot to 1.83 knots. The maximum drift was observed at 400 meters depth on 28 December 1960. A drift of 1.50 knots also was noted at the same depth on 17 December 1960. The average of all measurements of drift taken was 0.30 knot. The set of the maximum current drift observed on 28 December was 88° and that of the 17 December reading was 66°. A pressure type tide gauge was in operation at Scott Base on Pram Point, about 2 miles to the north of the icehole, during part of the time of observation. Tidal states, furnished through the cooperation of the New Zealand scientists working at Scott Base, are noted on some of the figures.

It had been expected that a portion of the strong current which sets westerly along the Ross shelf ice edge turned under the ice at Cape Crozier (at the extreme eastern end of Ross Island) and flowed south of the island and out into McMurdo Sound. An attempt to measure currents at the shelf ice edge near Cape Crozier with an icebreaker as a platform, had to be abandoned when a reconnaissance flight showed the shelf ice to be much too high for mooring. Located some 10 miles to the south of the icehole station are White and Black islands, and Minna Bluff. These form a southern boundary to the water area, and it is the opinion of the present authors that the current observed at the icehole is part of a large eddy which is a continuation of the Hut Point current. In the outer portions of McMurdo Sound, the current comes around Cape Byrd from the east, sets south along the western shores of Ross Island and then the greater portion cuts across the sound to the opposite shore and flows north along the Victoria Land Coast. There is very little current in evidence in the central portion of McMurdo Sound south of Cape Royds, but, along the shore at Hut Point and at Cape Armitage a strong current flows amounting to as much as 3 or 4 knots. This has been known since Scott's time to reverse its direction of flow with the tide. Apparently this current continues south and flows around and back out into the Sound again. On the other hand there may be some water, especially at greater depths, which flows toward the east, and this may go out from under the edge of the shelf ice near Cape Crozier. This question can be decided only when it is possible to measure the direction of flow of currents at Cape Crozier.

VI. GEOLOGY

The nature and depth of the bottom varied considerably, and it was assumed that this change was caused by the steady movement of the shelf ice pushing the relatively thinner fast ice along before it. Several years ago the rate of this movement was determined to be 8 inches per day at the site of the old air strip on the fast ice off NAF McMurdo. A similar rate would cause the icehole station to move about 20 feet per month. To determine the actual rate and direction of movement, the location of the hut was fixed by taking angles with a transit from the hut to Observation Hill, Crater Hill, and Castle Rock on Ross Island. These locations have prominent signals on their summits and their positions are well known. From fixes of the hut's position made on 13 February 1960 and a year later on 21 February 1961, it was determined that the hut had moved 249 feet to the south and 245 feet to the west during the 373 days. At a rate of 8 inches a day as computed for the airstrip, 373 days would total 248 feet, so that the two rates agree very well.

Since the general direction of movement at the airstrip had been northerly, it was assumed that the icehole hut also was moving in that direction. However, the actual direction of movement at the hut was a little south of southwest. This possibly may be explained by the position of the hut, which is far enough to the east to be more affected by the southwesterly movement of ice along the southern shores of Hut Point Peninsula than by the northerly movement of the ice mass to the west. The southwesterly movement now explains why the depths became increasingly greater toward the end of observations. A northerly movement would have produced shallowing depths according to the general depth trend pattern as shown by the north and south sounding line. It also has been shown that depths beneath the shelf ice south of the icehole hut, generally increase southward (Robinson, 1962).

In establishing the icehole station soundings were made during February and early March 1960. Table 11 summarizes results obtained by examining the very small bottom samples taken with the sounding tube in the new ice area. A list of the types of rocks and remains found is shown. Station numbers run from the icehole north to the new ice edge and then start at the eastern edge of the new ice area and run in a general westerly direction (Fig. 1). Samples A, B, and C are small cores taken at the icehole on 6 and 30 May 1960 and on 24 October 1960.

Table 12 summarizes findings from analyses of bottom samples taken at the icehole station. After 29 December 1960, an area of very hard bottom was reached in the course of the southwesterly

TABLE 11. SUMMARY OF SMALL BOTTOM SAMPLES COLLECTED FROM THE BOTTOM SOUNDING HOLES IN THE NEW ICE AREA

Station No.	2	3	4	6	8	9	17	18	20	21	22	23	24	25	26	A	B	C
Depth (M)	579	552	506	423	312	294	302	320	338	365	361	386	406	437	442	570	579	566
Fine grained basic igneous rock fragments	X		X	X					X					X			X	
Quartz, feldspar				X													X	X
Small pebbles of basalt porphyry		X					X									X		
Scoria (grayish red with pyroxene phenocrysts)					X									X				
Coarse sand	X	X	X	X					X									
Basalt fragments		X																
Siltstone fragments		X		X														X
Sandstone fragments		X																
Silicious shale fragments																		X
Finely divided detritus						X					X							
Bryozoans, erect, calcareous	X			X		X	X	X	X	X	X	X	X	X	X	X	X	X
Bryozoans, encrusting							X			X						X		
Silicious sponge spicules				X		X				X	X	X	X	X		X		X
Small gastropods		X		X				X	X	X	X	X	X			X		X
Pelecypods							X		X		X							X
Worm tubes, calcareous				X			X											
Worm tubes, silicious															X			
Worm tubes, chitenous					X													
Sea urchin spines				X						X								
Calcareous detritus	X		X			X	X		X	X	X		X		X		X	X
Foraminifera tests and fragments	X			X				X	X					X			X	X
Pteropod shells						X											X	
Magnetite				X					X					X				
Fine powdery residue of minute spicules													X					
Barnacle plate																X		
Sand																X	X	
Hydroid remains					X													

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TABLE 12. BOTTOM SAMPLES TAKEN AT THE ICEHOLE

Station Date	10 May 1960	13 Jun 1960	18 Jul 1960	20 Jul 1960	22 Jul 1960	25 Jul 1960	27 Jul 1960	9 Sep 1960	12 Oct 1960	23 Oct 1960	29 Nov 1960	3 Dec 1960	23 Dec 1960	29 Dec 1960
Depth (M)	570	566	566	566	566	566	566	566	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Color	Light Olive Gray	Dusky Brown	Olive Gray	Medium Olive Brown	Grayish Olive	Grayish Olive	Grayish Olive	Medium Olive Brown	Medium Olive Brown	Medium Olive Brown	Grayish Olive	Medium Olive Brown	Grayish Olive	Medium Olive Brown
Odor	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Plasticity	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Coarser Than Sand (<-1ø) (%)	40	23	49	57	50	26	66	54	62	21	41	-	[illegible]	62
Sand (%)	51	76	49	41	45	62	31	41	34	74	56	-	36	37
Silt (%) Clay (%)	8	Trace	3	2	2	11	3	4	4	5	3	-	3	2
Phi Median Diameter (Md ø)	-1.29	-0.16	-0.90	-0.76	-1.00	1.00	-3.10	-1.28	-1.81	0.38	-0.18	-	-2.67	-2.17
Phi Deviation Measure (σø)	2.53	1.31	-	2.33	-	-	[illegible]	-	2.72	[illegible]	[illegible]	-	-	-
Phi Skewness Measure (aø)	0.25	0.06	-	[illegible]	-	-	2.60	-	[illegible]	[illegible]	[illegible]	-	-	-
ø 16%	[illegible]	[illegible]	-	[illegible]	-	-	[illegible]	-	[illegible]	-1.30	[illegible]	-	-	-
ø 84%	1.87	1.23	1.52	1.03	1.74	3.53	1.28	[illegible]	[illegible]	[illegible]	[illegible]	-	1.12	1.10
Sediment Type	Pebbly Sand	Pebbly Sand	Sand & Pebbles	Pebbles & Sand	Pebbles & Sand	Pebbly Sand	Pebbles & Sand	Pebbles & Sand	Pebbles & Sand	Pebbly Sand	Pebbly Sand	Sponge [illegible] Sand	Pebbles & Sand	Pebbles & Sand
Shell Content (%)	30	35	40		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Trace	[illegible]	[illegible]
Magnetic Content (%)	[illegible]	5.3	[illegible]	[illegible]	3.0	[illegible]	1.1	[illegible]	[illegible]	[illegible]	[illegible]	Trace	[illegible]	[illegible]

movement of the icehole hut, so that not enough sample was obtained for analysis. In general, the bottom over the area sampled was very hard and was apparently uneven with pockets and ridges. Since most of the ice-deposited sediment is not dropped from the shelf ice until it reaches a more northerly latitude, as pointed out by Lisitsyn (1960), sediment was found in the pockets (the large Peterson grab would often be completely filled); on the ridges, it was impossible to obtain any sediment. Color was variable with grayish olive and medium olive brown being dominant. Other colors noted were light olive brown and dusky brown. None of the samples had any odor, whatsoever. This contrasted sharply with the sediments taken in Newcomb Bay at Wilkes Station, where many of the samples had a strong fishy or sulphurous smell (Tressler, 1960). Grain size was too large for any plasticity to be evidenced. The greater portion of all samples consisted of pebbles and sand; the amount of silt and clay was small. About one-half of most samples consisted of particles larger than sand size. With one exception, the sediments were poorly sorted. A sample taken on 27 July 1960 showed a Phi Deviation Measure of 0.18 with a Phi 84% figure of 1.28. Bottom currents apparently account for the well sorted condition of this sample. It will be noted that magnetic content of the samples was rather low. Those samples showing only traces of magnetic minerals were composed primarily of biological detritus (silicious sponge spicules, etc.) rather than sediments. This probably accounts for their unusually low percent of magnetic minerals. The magnetic materials found in the samples are in the form of weathered basic rock fragments probably containing mud and magnetite. Only a few samples showed siliceous sponge spicules in any great amount. The often encountered mat of sponge spicules of the outer areas of McMurdo Sound, was not found at the icehole. The greater depth of water apparently accounts for this fact as was earlier mentioned by Beliaev and Ushakov (1957) and reported on in Lisitsyn's account of the bottom sediments of the Eastern Antarctic and southern Indian Ocean (Lisitsyn, 1960). Beliaev and Ushakov found siliceous sponges dominant at depths of less than 400 meters. Evidently, the large sponges from which the spicules were derived do not live in the deeper water adjacent to the icehole, and the presence of scattered spicules indicates current activity.

Field inspection notes and bottom sediment analysis sheets are presented as Appendix B.

VII. BIOLOGY

In the small samples taken across the new ice area, shell content varied between 0 and 60% and averaged 40% (Table 11). All but three contained erect, calcareous Bryozoan remains. About half contained silicious sponge spicules (probably derived from the very large silicious sponges which live out in the open portions of the Sound). Small gastropods were frequent and there was a considerable representation of broken shell fragments which has been lumped together as "calcareous detritus." The bottom, even under what until recently had been more or less permanently ice-covered water, appears to be very rich in invertebrate life. Among the organisms found on the bottom at the icehole or in the water are the following: 5 species of fish, spongin sponges, calcareous hydroids, sea cucumbers, sea urchins, starfish, brittle stars, several types of isopods, sea spiders, shrimp, prawns, two forms of amphipods, various tubed annelids, barnacles, nemertine worms, bryozoans, pteropods, ostracods, pelecypods, brachiopods, several species of sessile turnicates, foraminifera, gastropods, and one squid. Some of the fish living near the bottom were caught in a fish trap, while others were caught on hook and line or with a dip net at the surface. Those which were tried were found to be good eating. There also were two kinds of amphipods, one living in the upper waters and the other at great depths. Bait in fish traps came up covered with them and fish left in live cans in the icehole were soon killed and reduced to skeletons overnight, all the work of these voracious little creatures.

VIII. METEOROLOGY

Air temperatures dropped steadily during May and June reaching their lowest values in early July when on three successive days (6, 7, and 8 July) temperatures of -67^{o}, -72^{o}, and $-68^{o}F$. were observed at the icehole. The lowest air temperature observed at the main base was $-59^{o}F$. on 8 July 1960. Table 13 shows daily maximum and minimum air temperatures, peak gusts (high), and average wind velocities for NAF McMurdo during the period of oceanographic observation. Figure 25 shows minimum air temperatures at NAF McMurdo, and minimum observed air temperatures at the icehole. A minimum thermometer was not installed until late in the winter, and the figures given as observed minima for the main part include only the minimum for the day on which work was being done at the icehole. The figures for March 1960 were taken from minima recorded at NAF McMurdo on days when there was appreciable wind. It was noted that temperatures at NAF McMurdo and at the icehole were almost identical on windy days, whereas, during calm periods, the air temperatures were from 15 to 20 degrees colder at the icehole. This great difference in only three miles distance was explained by the sea level elevation of the icehole compared with an elevation of around 100 feet for the meteorological station at NAF McMurdo. On some days when there was a fairly strong wind blowing in camp, comparative calm existed on the ice south of the Gap. On rarer occasions, the reverse occurred. Most storms during the winter came from the south or southeast. A wind from the north usually was followed by stormy weather and a shift in the wind direction toward the south. Winds from the southwest or west were rare occurrences.

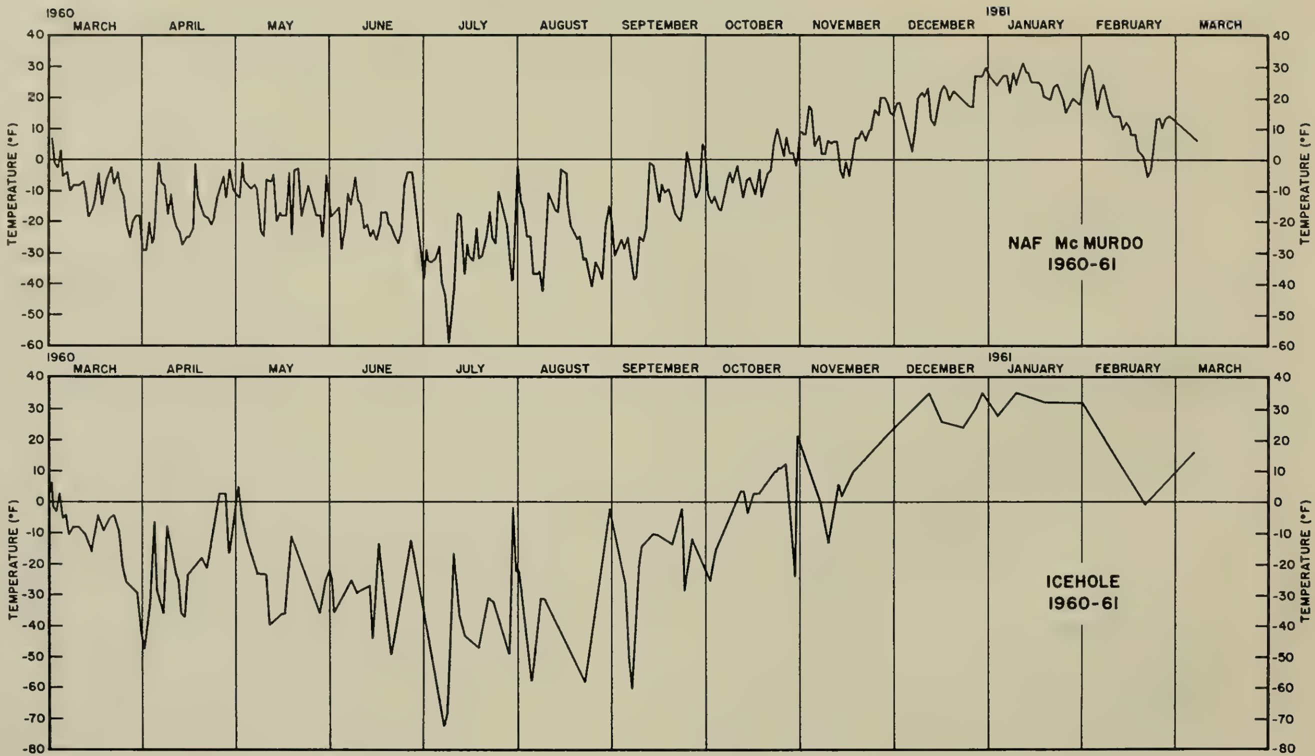

FIGURE 25. MINIMUM AIR TEMPERATURES AT NAF MCMURDO AND MINIMUM OBSERVED AIR TEMPERATURES AT THE ICEHOLE

TABLE 13. TEMPERATURE AND WIND VELOCITIES AT NAF MCMURDO DURING THE PERIOD OF OBSERVATION

Date 1960	Temperature (°F)		Wind (Kn)		Date 1960	Temperature (°F)		Wind (Kn)		Date 1960	Temperature (°F)		Wind (Kn)		Date 1960	Temperature (°F)		Wind (Kn)		Date 1960	Temperature (°F)		Wind (Kn)		Date 1960	Temperature (°F)		Wind (Kn)	
	Max	Min	High	Ave		Max	Min	High	Ave		Max	Min	High	Ave		Max	Min	High	Ave		Max	Min	High	Ave		Max	Min	High	Ave
Mar 1	13	7	28	11	Apr 1	-17	-29	18	3	May 1	2	-12	66	26	Jun 1	-1	-18	43	14	Jul 1	-22	-29	26	16	Aug 1	2	-13	36	1
2	11	-1	40	12	2	-17	-20	20	4	2	6	0	56	23	2	-8	-17	26	6	2	-22	-29	26	16	2	-6	-17	38	11
3	2	-3	40	20	3	-19	-27	17	4	3	3	-7	58	19	3	-9	-15	28	11	3	-22	-33	26	2	3	-13	-25	28	10
4	14	3	32	16	4	2	-22	42	16	4	5	-8	38	13	4					4	-25	-32	25	7	4	-20	-25	33	20
5	17	-5	41	20	5	5	-1	31	7	5	-3	-9	33	6	5	-11	-23	31	13	5	-22	-28	29	17	5	-19	-37	28	3
6	4	-4	45	26	6	1	-7	42	16	6	0	-8	13	1	6	-1	-11	34	11	6	-25	-40	28	8	6	-19	-37	28	3
7	-7	-10	46	26	7	1	-8	45	15	7	2	-10	24	8	7	-1	-15	42	8	7	-32	-44	10	1	7	-22	-36	20	1
8	-2	-8	32	15	8	-5	-18	47	8	8	-6	-23	44	19	8	5	-6	40	14	8	-32	-59	14	2	8	-11	-42	20	6
9	-	-	-	-	9	-3	-11	45	23	9	-5	-25	49	21	9	-4	-13	34	12	9	-34	-54	20	6	9	5	-22	33	7
10	-3	-8	33	20	10	1	-17	47	18	10	2	-6	34	11	10	-8	-14	39	9	10	-13	-38	29	15	10	2	-11	41	27
11	6	-7	34	10	11	-16	-21	40	27	11	2	-7	21	4	11	-9	-22	30	12	11	-5	-17	34	12	11	-2	-14	35	16
12	1	-10	36	20	12	-15	-23	40	24	12	0	-5	12	3	12	-11	-21	37	10	12	-5	-18	28	10	12	-2	-17	43	19
13	-8	-18	36	19	13	-15	-27	46	31	13	-2	-20	44	26	13	-13	-25	20	7	13	-5	-37	23	6	13	-2	-17	45	22
14	-3	-16	38	3	14	-17	-25	30	5	14	-8	-17	64	32	14	-16	-23	9	1	14	-14	-27	25	2	14	2	-3	44	19
15	6	-13	40	16	15	-18	-25	18	1	15	-8	-18	41	23	15	-16	-26	20	2	15	-11	-31	39	10	15				
16	9	-4	34	15	16	1	-23	23	4	16	-3	-18	41	11	16	-16	-23	9	1	16	-12	-33	26	6	16	5	-13	17	11
17	1	-14	40	22	17	4	-1	28	13	17	5	-4	39	13	17	-7	-17	28	4	17	-5	-22	38	12	17	-6	-21	36	13
18	1	-9	41	23	18	3	-12	37	13	18	4	-23	62	21	18	-5	-17	26	8	18	-12	-32	40	14	18	-15	-23	32	17
19	2	-5	35	15	19	0	-14	38	15	19	9	-3	46	16	19	-5	-21	46	16	19	-18	-31	27	7	19	-18	-26	20	7
20	6	-2	44	20	20	-11	-18	40	27	20	6	-3	52	24	20	-15	-22	26	5	20	-14	-26	21	3	20	-11	-25	33	14
21	3	-8	44	18	21	-14	-19	39	23	21	-1	-18	44	23	21	-18	-25	16	3	21	-4	-16	34	14	21	-20	-32	29	8
22	4	-4	26	7	22	-13	-21	44	26	22	-1	-15	44	20	22	-7	-27	33	4	22	-1	-25	37	9	22	-22	-32	12	1
23	3	-10	39	20	23	-12	-18	30	5	23	1	-8	43	24	23	-1	-23	22	6	23	6	-27	50	15	23	-23	-37	21	3
24	-2	-12	40	15	24	-3	-12	38	15	24	1	-11	48	29	24	16	-4	75	32	24	-1	-10	45	23	24	-26	-42	10	0
25	-15	-20	46	26	25	5	-9	37	14	25	-5	-15	42	30	25	16	-4	75	32	25	1	-15	36	15	25	-30	-33	25	14
26	-18	-25	50	25	26	2	-5	42	18	26	-12	-18	30	23	26	6	-4	42	17	26	-2	-20	30	14	26	-29	-35	26	12
27	-9	-20	22	4	27	-2	-12	36	17	27					27	-6	-10	33	19	27	-15	-26	34	18	27	-21	-39	20	3
28	-10	-18	28	15	28	5	-3	53	20	28	-15	-25	25	13	28	-6	-17	26	4	28	-2	-39	22	4	28	-5	-22	40	15
29	-9	-18	17	1	29	6	-9	40	13	29	4	-4	10	5	29	-10	-27	37	16	29	-2	-39	22	4	29	-4	-15	43	16
30	-9	-29	41	23	30	-4	-11	50	25	30	-3	-13	21	15	30	-26	-39	39	11	30	9	-2	39	11	30	-6	-19	28	12
31	-20	-30	38	24						31	-6	-10	24	9						31	7	-2	70	26	31	2	-15	60	20

TABLE 13. TEMPERATURE AND WIND VELOCITIES AT NAF MCMURDO DURING THE PERIOD OF OBSERVATION (Cont'd)

Date 1960	Temperature (°F) Max	Min	Wind (Kn) High	Ave	Date 1960	Temperature (°F) Max	Min	Wind (Kn) High	Ave	Date 1960	Temperature (°F) Max	Min	Wind (Kn) High	Ave	Date 1960	Temperature (°F) Max	Min	Wind (Kn) High	Ave	Date 1961	Temperature (°F) Max	Min	Wind (Kn) High	Ave	Date 1961	Temperature (°F) Max	Min	Wind (Kn) High	Ave
Sept 1	2	-32	37	16	Oct 1	8	-11	32	18	Nov 1	9	9	48	14	Dec 1	26	18	27	13	Jan 1	30	26	27	14	Feb 1	33	28	44	29
2	5	-9	32	12	2	-1	-14	35	11	2	28	8	66	23	2	25	18	20	8	2	34	25	28	10	2	35	31	45	17
3	-7	-26	39	10	3	0	-12	31	10	3	29	17	42	18	3	25	14	23	9	3	31	24	26	10	3	34	29	20	6
4	-13	-29	38	11	4	0	-16	31	14	4	29	16	26	10	4	26	10	32	16	4	32	26	23	7	4	32	22	35	13
5	-15	-25	32	17	5	-2	-17	16	3	5	24	4	30	12	5	19	6	39	17	5	32	27	16	8	5	24	16	29	18
6	-24	-30	36	17	6	10	-13	41	15	6	16	8	31	16	6	16	2	41	16	6	34	27	30	6	6	28	22	23	13
7	-25	-39	38	15	7	10	-7	43	16	7	14	2	32	18	7	22	9	18	7	7	31	21	31	8	7	32	24	18	3
8	-15	-38	33	14	8	12	-4	47	13	8	10	2	31	16	8	32	20	39	10	8	33	29	35	14	8	25	21	23	9
9	-13	-25	56	17	9	13	-8	44	24	9	12	6	24	8	9	34	22	20	8	9	30	24	42	13	9	24	15	30	17
10	-13	-27	36	13	10	11	-2	35	15	10	11	5	28	9	10	27	20	26	13	10	37	28	32	12	10	20	14	26	16
11	-1	-22	22	6	11	6	-6	36	17	11	14	6	16	5	11	29	24	19	6	11	42	32	25	8	11	21	14	27	14
12	8	-1	67	35	12	-2	-13	32	13	12	13	6	16	7	12	28	13	34	17	12	40	28	20	8	12	19	14	24	9
13	9	-2	40	14	13	10	-7	23	6	13	10	-4	31	15	13	24	11	32	16	13	34	28	14	4	13	21	10	25	9
14	9	-6	43	20	14	8	-6	34	15	14	2	-6	35	19	14	31	16	11	3	14	32	25	18	7	14	17	12	30	18
15	-1	-14	45	18	15	-4	-10	31	21	15	6	0	30	17	15	30	22	26	7	15	29	25	23	12	15	18	11	19	13
16	4	-8	43	10	16	-2	-11	20	8	16	8	-6	27	20	16	30	24	29	9	16	29	25	26	14	16	12	8	30	17
17	6	-11	53	19	17	2	-3	22	13	17	12	3	16	5	17	31	22	26	9	17	30	24	25	14	17	13	8	26	15
18	0	-9	42	17	18	3	-13	35	11	18	12	7	9	4	18	27	19	34	17	18	27	20	33	15	18	10	3	36	26
19	6	-13	36	19	19	6	-8	31	11	19	15	7	14	7	19	26	22	25	11	19	25	20	30	13	19	13	2	36	21
20	-8	-17	31	11	20	0	-5	43	23	20	18	9	33	8	20	29	21	29	12	20	29	19	24	8	20	5	1	38	24
21	-5	-18	37	15	21	7	-4	55	25	21	15	6	32	11	21	26	20	23	9	21	28	23	40	15	21	8	-6	33	16
22	4	-20	51	18	22	18	7	38	17	22	19	9	23	6	22	29	19	22	7	22	31	24	32	10	22	8	-4	33	15
23	8	-16	40	17	23	16	10	36	18	23	19	10	27	13	23	28	18	29	12	23	30	21	26	11	23	18	0	29	3
24	10	3	36	9	24	14	4	33	18	24	27	16	28	9	24	20	17	30	15	24	24	19	28	14	24	18	13	56	29
25	9	-3	29	4	25	11	0	22	11	25	26	14	27	12	25	29	17	33	13	25	28	15	25	10	25				
26	2	-6	18	4	26	15	7	67	19	26	25	20	40	12	26	34	27	29	9	26	28	17	23	13	26				
27	-2	-13	56	20	27	11	2	38	21	27	27	20	40	15	27	37	27	41	15	27	28	20	32	14	27				
28	6	-10	60	20	28	7	2	32	17	28	30	19	28	12	28	36	27	33	15	28	24	19	30	16	28				
29	14	6	64	26	29	6	-2	25	12	29	26	15	27	13	29	37	30	22	10	29	26	18	24	11					
30	13	3	30	15	30	10	0	20	9	30	22	14	29	13	30	34	29	21	7	30	27	19	13	4					
					31	24	9	42	14						31	32	27	32	15	31	29	19	54	21					

IX. ACKNOWLEDGMENTS

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APPENDIX A

OCEANOGRAPHIC STATION DATA

NODC REFERENCE NUMBER 00598

EXPLANATION OF OCEANOGRAPHIC STATION DATA

A. General

Each of the items appearing on the data pages is explained below. The vertical arrows shown in some of the column headings indicate the location of decimal points. The presence of asterisks to the left of data indicates those data are doubtful; hence, they were not used in the construction of the curve from which interpolated values (standard depth values) were derived. Observed values which were obviously invalid were omitted entirely.

B. Surface Observations

1. Reference Number. This number is arbitrarily assigned. It identifies the data and provides a means of sorting from the IBM files all cards pertaining to that particular project. The reference number is also presented on the flysheet for the tabulated oceanographic data.

2. Station Number. Stations are numbered to designate a certain station location; however, stations are presented in the chronological order in which they were occupied.

3. Date. Month, day and year are given in Arabic numerals. The hour is Greenwich Mean Time and is that hour nearest to the messenger time of the first cast.

4. Latitude and Longitude. The position of the station is given in degrees and minutes.

5. Sonic Depth. Sonic Depth is the uncorrected sounding for the station, recorded in meters.

6. Maximum Sample Depth. The maximum depth from which a water sample was obtained at the station is given to the nearest 100 meters.

7. Wind. Wind speed is given in meters per second. Direction from which the wind blows is coded in degrees true to the nearest ten degrees. The last zero is omitted. North is 36 on this scale and calm is 0. See Table 1, Compass Direction Conversion Table for Wind, Sea, and Swell Directions.

8. Anemometer Height. The height of the anemometer above the waterline is given in meters.

9. Air Pressure. Barometric pressure is coded in millibars, neglecting the 900 or 1000. Thus, 996 millibars is coded as 96 and 1008 millibars is coded as 08.

10. Air Temperature. Dry bulb and wet bulb temperatures are entered to the nearest tenth of a degree (Celsius). A negative temperature is coded by dropping the minus sign and adding 50, thus -10° is coded as 60.

11. Humidity. The percent of humidity is coded directly, 100 percent being coded as 99.

12. Weather. Weather is coded as indicated in Table 2, Numerical Weather Codes - Present Weather.

13. Cloud. Cloud type and amount are coded as indicated in Tables 3, Cloud Type, and 4, Cloud Amount.

14. Sea. Sea direction and amount are coded as indicated in Tables 1 and 5, respectively.

15. Swell. Swell direction and amount are coded as indicated in Tables 1 and 6, respectively.

16. Visibility. Visibility is coded as indicated in Table 7, Visibility.

17. Water. Color is coded as indicated in Table 8, Water Color. Transparency is coded in whole meters from observations taken with a white Secchi disc (30 cm. dia.).

C. Subsurface Observations

1. Sample Depth. Observed (actual) depth of each sample is given in meters. Interpolated values of standard depths are also given. The standard depths, in meters, are: 0, 10, 20, 30, 50, 75, 100, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000, 2500, 3000, and thence every 1000 meters.

2. Temperature. The Celsius (°C) temperature is given in degrees and hundredths.

3. Salinity. Salinity is given in parts per thousand (by weight) to two decimal places.

4. Sigma-t. To convert to density divide by 1000 and add 1. Thus, a sigma-t value of 22.35 converts to a density of 1.02235.

5. Delta-D. The values in the columns are the anomalies of dynamic depths from the surface to each level in dynamic meters. Each entry is the cumulative sum of the anomalies of dynamic depth of the layer above. These values have been computed for the standard depths only, and serve to identify computed points.

6. Dissolved Oxygen. These values when given are in milliliters per liter to two decimal places. Values of 10.00 or above rarely occur and are coded as 9.99.

7. Sound Velocity[1]. Sound velocity is given in feet per second to one decimal place, corrected to pressure at each depth. See footnote 1 on page 48.

TABLE 1. COMPASS DIRECTION CONVERSION TABLE FOR WIND, SEA, AND SWELL DIRECTIONS

Code	Direction	Code	Direction
00	------ Calm	19	------ 185° to 194°
01	------ 5° to 14°	20	------ 195° to 204° SSW
02	------ 15° to 24° NNE	21	------ 205° to 214°
03	------ 25° to 34°	22	------ 215° to 224°
04	------ 35° to 44°	23	------ 225° to 234° SW
05	------ 45° to 54° NE	24	------ 235° to 244°
06	------ 55° to 64°	25	------ 245° to 254° WSW
07	------ 65° to 74° ENE	26	------ 255° to 264°
08	------ 75° to 84°	27	------ 265° to 274° W
09	------ 85° to 94° E	28	------ 275° to 284°
10	------ 95° to 104°	29	------ 285° to 294° WNW
11	------ 105° to 114° ESE	30	------ 295° to 304°
12	------ 115° to 124°	31	------ 305° to 314°
13	------ 125° to 134°	32	------ 315° to 324° NW
14	------ 135° to 144° SE	33	------ 325° to 334°
15	------ 145° to 154°	34	------ 335° to 344° NNW
16	------ 155° to 164° SSE	35	------ 345° to 354°
17	------ 165° to 174°	36	------ 355° to 4° N
18	------ 175° to 184° S	99	------ Variable or unknown

TABLE 2. NUMERICAL WEATHER CODES—PRESENT WEATHER

00 Cloud development NOT observed or NOT observable during past hour	**01** Clouds generally dissolving or becoming less developed during past hour	**02** State of sky on the whole unchanged during past hour.	**03** Clouds generally forming or developing during past hour	**04** Visibility reduced by smoke.	**05** Haze.	**06** Widespread dust in suspension in the air, NOT raised by wind, at time of observation.	**07** Dust or sand raised by wind, at time of observation.	**08** Well developed dust devil(s) within past hour.	**09** Duststorm or sandstorm within sight of or at station during past hour.
10 Light fog	**11** Patches of shallow fog at station, NOT deeper than 6 feet on land	**12** More or less continuous shallow fog at station, NOT deeper than 6 feet on land.	**13** Lightning visible, no thunder heard.	**14** Precipitation within sight, but NOT reaching the ground.	**15** Precipitation within sight, reaching the ground, but distant from station.	**16** Precipitation within sight, reaching the ground, near to but NOT at station.	**17** Thunder heard, but no precipitation at the station.	**18** Squall(s) within sight during past hour.	**19** Funnel cloud(s) within sight during past hour.
20 Drizzle (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.	**21** Rain (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob	**22** Snow (NOT falling as showers) during past hour, but NOT at time of observation	**23** Rain and snow (NOT falling as showers) during past hour, but NOT at time of observation	**24** Freezing drizzle or freezing rain (NOT falling as showers) during past hour, but NOT at time of observation.	**25** Showers of rain during past hour, but NOT at time of observation.	**26** Showers of snow, or of rain and snow, during past hour, but NOT at time of observation.	**27** Showers of hail, or of hail, and rain, during past hour, but NOT at time of observation.	**28** Fog during past hour, but NOT at time of observation.	**29** Thunderstorm (with or without precipitation) during past hour, but NOT at time of observation.
30 Slight or moderate duststorm or sandstorm has decreased during past hour.	**31** Slight or moderate duststorm or sandstorm no appreciable change during past hour	**32** Slight or moderate duststorm or sandstorm has increased during past hour.	**33** Severe duststorm or sandstorm, has decreased during past hour.	**34** Severe duststorm or sandstorm, no appreciable change during past hour.	**35** Severe duststorm or sandstorm, has increased during past hour.	**36** Slight or moderate drifting snow, generally low.	**37** Heavy drifting snow, generally low.	**38** Slight or moderate drifting snow, generally high.	**39** Heavy drifting snow, generally high.
40 Fog at distance at time of observation, but NOT at station during past hour.	**41** Fog in patches	**42** Fog, sky discernible, has become thinner during past hour.	**43** Fog, sky NOT discernible, has become thinner during past hour.	**44** Fog, sky discernible, no appreciable change during past hour.	**45** Fog, sky NOT discernible no appreciable change during past hour.	**46** Fog, sky discernible, has begun or become thicker during past hour.	**47** Fog, sky NOT discernible, has begun or become thicker during past hour.	**48** Fog, depositing rime, sky discernible.	**49** Fog, depositing rime, sky not discernible.
50 Intermittent drizzle (NOT freezing) slight at time of observation.	**51** Continuous drizzle (NOT freezing) slight at time of observation	**52** Intermittent drizzle (NOT freezing) moderate at time of ob.	**53** Continuous drizzle (NOT freezing), moderate at time of ob.	**54** Intermittent drizzle (NOT freezing), thick at time of observation.	**55** Continuous drizzle (NOT freezing), thick at time of observation.	**56** Slight freezing drizzle.	**57** Moderate or thick freezing drizzle.	**58** Drizzle and rain, slight.	**59** Drizzle and rain, moderate or heavy.
60 Intermittent rain (NOT freezing), slight at time of observation.	**61** Continuous rain (NOT freezing), slight at time of observation	**62** Intermittent rain (NOT freezing), moderate at time of ob.	**63** Continuous rain (NOT freezing), moderate at time of observation.	**64** Intermittent rain (NOT freezing), heavy at time of observation.	**65** Continuous rain (NOT freezing), heavy at time of observation.	**66** Slight freezing rain.	**67** Moderate or heavy freezing rain.	**68** Rain or drizzle and snow, slight.	**69** Rain or drizzle and snow, moderate or heavy.
70 Intermittent fall of snowflakes, slight at time of observation	**71** Continuous fall of snowflakes, slight at time of observation.	**72** Intermittent fall of snowflakes, moderate at time of observation.	**73** Continuous fall of snowflakes, moderate at time of observation.	**74** Intermittent fall of snowflakes, heavy at time of observation.	**75** Continuous fall of snowflakes, heavy at time of observation.	**76** Ice needles (with or without fog).	**77** Granular snow (with or without fog).	**78** Isolated starlike snow crystals (with or without fog).	**79** Ice pellets (sleet, U. S. definition).
80 Slight rain shower(s)	**81** Moderate or heavy rain shower(s)	**82** Violent rain shower(s).	**83** Slight shower(s) of rain and snow mixed.	**84** Moderate or heavy shower(s) of rain and snow mixed.	**85** Slight snow shower(s).	**86** Moderate or heavy snow shower(s).	**87** Slight shower(s) of soft or small hail with or without rain or rain and snow mixed.	**88** Moderate or heavy shower(s) of soft or small hail with or without rain or rain and snow mixed.	**89** Slight shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder.
90 Moderate or heavy shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder	**91** Slight rain at time of ob., thunderstorm during past hour, but NOT at time of observation.	**92** Moderate or heavy rain at time of ob.; thunderstorm during past hour, but NOT at time of observation.	**93** Slight snow or rain and snow mixed or hail at time of observation., thunderstorm during past hour, but not at time of observations.	**94** Mod. or heavy snow, or rain and snow mixed or hail at time of ob.; thunderstorm during past hour, but NOT at time of observation.	**95** Slight or mod. thunderstorm without hail, but with rain and/or snow at time of observation.	**96** Slight or moderate thunderstorm, with hail at time of observation.	**97** Heavy thunderstorm, without hail, but with rain and/or snow at time of observation.	**98** Thunderstorm combined with duststorm or sandstorm at time of observation.	**99** Heavy thunderstorm with hail at time of observation.

TABLE 3. CLOUD TYPE

Code	
0	Stratus or Fractostratus
1	Cirrus
2	Cirrostratus
3	Cirrocumulus
4	Altocumulus
5	Altostratus
6	Stratocumulus
7	Nimbostratus
8	Cumulus or Fractocumulus
9	Cumulonimbus

TABLE 4. CLOUD AMOUNT

Code	
0	No clouds
1	Less than 1/10 or 1/10
2	2/10 and 3/10
3	4/10
4	5/10
5	6/10
6	7/10 and 8/10
7	9/10 and 9/10 plus
8	10/10
9	Sky obscured

TABLE 5. SEA AMOUNT

Code	Mean Max. Height of Sea Waves in feet (Approx.)	Description
0	0	Calm (glassy)
1	0 - 1/3	Calm (rippled)
2	1/3 - 1-2/3	Smooth (wavelets)
3	1-2/3 - 4	Slight
4	4 - 8	Moderate
5	8 - 13	Rough
6	13 - 20	Very rough
7	20 - 30	High
8	30 - 45	Very high
9	over 45	Phenomenal*

* As might be expected in center of hurricane

TABLE 6. SWELL AMOUNT

Code	Approximate Height (feet)	Description		Approximate Length (feet)
0	----	No swell		----
1	1 to 6	Low swell	Short or Average	0 to 600
2			Long	Above 600
3	6 to 12	Moderate	Short	0 to 300
4			Average	300 to 600
5			Long	Above 600
6	Greater than 12	High	Short	0 to 300
7			Average	300 to 600
8			Long	Above 600
9	----	Confused		----

TABLE 7. VISIBILITY

Code		
0	Dense fog	50 yards
1	Thick fog	200 yards
2	Fog	400 yards
3	Moderate fog	1000 yards
4	Thin fog or mist	1 mile
5	Visibility poor	2 miles
6	Visibility moderate	5 miles
7	Visibility good	10 miles
8	Visibility very good	30 miles
9	Visibility excellent	Over 30 miles

TABLE 8. WATER COLOR

Code (Percent yellow)	Description
00	Deep blue
10	Blue
20	Greenish-blue (or green blue)
30	Bluish-green (or blue green)
40	Green
50	Light green
60	Yellowish-green
70	Yellow green
80	Green yellow
90	Greenish-yellow
99	Yellow

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0001	05	04	1960	01	77° 53′ S	166° 44′ E	0570	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMID-ITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
03			99	75 0					0							11

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 72	34 45	27 75	0 000	6 50	4713 4
OBS	0000	-01 72	34 45	27 75		6 50	4713 4
STD	0010	-01 89	34 48	27 78	0 003	6 42	4711 4
OBS	0010	-01 89	34 48	27 78		6 42	4711 4
STD	0020	-01 89	34 49	27 79	0 007	6 40	4712 0
OBS	0020	-01 89	34 49	27 79		6 40	4712 0
STD	0030	-01 88	34 52	27 81	0 010	6 39	4712 9
OBS	0030	-01 88	34 52	27 81		6 39	4712 9
OBS	0040	-01 88	34 50*	27 79*		6 42	4713 4*
STD	0050	-01 87	34 52	27 81	0 016	6 38	4714 2
OBS	0050	-01 87	34 52	27 81		6 38	4714 2
STD	0075	-01 84	34 54	27 83	0 023	6 42	4716 3
OBS	0075	-01 84	34 54	27 83		6 42	4716 3
STD	0100	-01 81	34 60	27 87	0 029	5 98	4718 5
OBS	0100	-01 81	34 60	27 87		5 98	4718 5
STD	0150	-01 86	34 67	27 93	0 039	5 87	4721 0
OBS	0150	-01 86	34 67	27 93		5 87	4721 0
STD	0200	-01 88	34 68	27 94	0 048	5 96	4723 7
OBS	0200	-01 88	34 68	27 94		5 96	4723 7
STD	0250	-01 87	34 71	27 97	0 055	5 65	4727 0
OBS	0250	-01 87	34 71	27 97		5 65	4727 0
STD	0300	-01 86	34 73	27 98	0 062	5 62	4730 2
OBS	0300	-01 86	34 73	27 98		5 62	4730 2
OBS	0350	-01 87	34 72*	27 97*		5 60	4733 0*
STD	0400	-01 87	34 79	28 03	0 071	5 58	4736 2
OBS	0400	-01 87	34 79	28 03		5 58	4736 2
OBS	0450	-01 86	34 78	28 02		5 59	4739 3
STD	0500	-01 88	34 78	28 02	0 078	5 57	4742 0
OBS	0500	-01 88	34 78	28 02		5 57	4742 0
OBS	0550	-01 90	34 79	28 03		5 58	4744 7
OBS	0565	-01 88	34 80	28 04		5 72	4745 9

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0002	05	15	1960	24	77° 53' S	166° 44' E	0570	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
00			98	82 0					0							13

	SUBSURFACE OBSERVATIONS						
	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 86	34 51	27 80	0 000	6 23	4711 4
OBS	0000	-01 86	34 51	27 80		6 23	4711 4
OBS	0005	-01 88	34 54	27 83		6 23	4711 5
STD	0010	-01 87	34 54	27 83	0 003	6 21	4712 0
OBS	0010	-01 87	34 54	27 83		6 21	4712 0
STD	0020	-01 86	34 56	27 84	0 006	6 18	4712 8
OBS	0020	-01 86	34 56	27 84		6 18	4712 8
STD	0030	-01 87	34 56	27 84	0 008	6 17	4713 2
OBS	0030	-01 87	34 56	27 84		6 17	4713 2
STD	0050	-01 84	34 59	27 87	0 013	6 00	4715 0
OBS	0050	-01 84	34 59	27 87		6 00	4715 0
STD	0075	-01 85	34 59	27 87	0 019	6 01	4716 4
OBS	0075	-01 85	34 59	27 87		6 01	4716 4
STD	0100	-01 81	34 62	27 89	0 025	5 91	4718 6
OBS	0100	-01 81	34 62	27 89		5 91	4718 6
STD	0150	-01 80	34 65	27 91	0 035	5 73	4721 9
OBS	0150	-01 80	34 65	27 91		5 73	4721 9
STD	0200	-01 83	34 67	27 93	0 045	5 67	4724 5
OBS	0200	-01 83	34 67	27 93		5 67	4724 5
STD	0250	-01 84	34 68	27 94	0 053	5 64	4727 3
OBS	0250	-01 84	34 68	27 94		5 64	4727 3
STD	0300	-01 84	34 69	27 95	0 061	5 63	4730 3
OBS	0300	-01 84	34 69	27 95		5 63	4730 3
OBS	0350	-01 88	34 75	28 00		5 63	4732 9
STD	0400	-01 87	34 75	28 00	0 073	5 62	4736 1
OBS	0400	-01 87	34 75	28 00		5 62	4736 1
OBS	0450	-01 87	34 76	28 01		5 60	4739 1
STD	0500	-01 88	34 80	28 04	0 081	5 58	4742 1
OBS	0500	-01 88	34 80	28 04		5 58	4742 1
OBS	0550	-01 90	34 79	28 03		5 59	4744 7
OBS	0565	-01 86	34 78	28 02		5 51	4746 2

SURFACE OBSERVATIONS									
NODC REF NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0003	05	27	1960	00	77° 53' S	166° 44' E	0570	06

WIND		ANEMO HGT	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR	AMT.		COL.	TRANS.
00	00			87 8			00		0							15

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 43	34 59	27 86	0 000	6 08	4718 5
OBS	0000	-01 43	34 59	27 86		6 08	4718 5
OBS	0005	-01 88	34 59	27 87		6 08	4711 7
STD	0010	-01 88	34 61	27 88	0 002	6 13	4712 1
OBS	0010	-01 88	34 61	27 88		6 13	4712 1
STD	0020	-01 88	34 60	27 88	0 005	6 07	4712 7
OBS	0020	-01 88	34 60	27 88		6 07	4712 7
STD	0030	-01 90	34 62	27 89	0 007	6 10	4713 0
OBS	0030	-01 90	34 62	27 89		6 10	4713 0
STD	0050	-01 88	34 63	27 90	0 011	6 01	4714 6
OBS	0050	-01 88	34 63	27 90		6 01	4714 6
STD	0075	-01 86	34 66	27 92	0 016	5 86	4716 5
OBS	0075	-01 86	34 66	27 92		5 86	4716 5
STD	0100	-01 84	34 66	27 92	0 021	5 82	4718 3
OBS	0100	-01 84	34 66	27 92		5 82	4718 3
STD	0150	-01 87	34 69	27 95	0 030	5 76	4720 9
OBS	0150	-01 87	34 69	27 95		5 76	4720 9
STD	0200	-01 87	34 72	27 97	0 037	5 67	4724 0
OBS	0200	-01 87	34 72	27 97		5 67	4724 0
STD	0250	-01 89	34 73	27 98	0 043	5 67	4726 7
OBS	0250	-01 89	34 73	27 98		5 67	4726 7
STD	0300	-01 89	34 73	27 98	0 049	5 67	4729 7
OBS	0300	-01 89	34 73	27 98		5 67	4729 7
OBS	0350	-01 88	34 75	28 00		5 66	4732 9
STD	0400	-01 87	34 75	28 00	0 060	5 69	4736 1
OBS	0400	-01 87	34 75	28 00		5 69	4736 1
OBS	0450	-01 88	34 74	27 99		5 72	4738 8
STD	0500	-01 90	34 76	28 01	0 070	5 87	4741 6
OBS	0500	-01 90	34 76	28 01		5 87	4741 6
OBS	0550	-01 90	34 78	28 02		5 64	4744 6
OBS	0565	-01 90	34 81	28 05		5 63	4745 7

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0004	06	06	1960	23	77° 53′ S	166° 44′ E	0566	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
03	15		55	76 7			01									16

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 48	34 42	27 72	0 000	6 41	4717 0
OBS	0000	-01 48	34 42	27 72		6 41	4717 0
OBS	0005	-01 87	34 57	27 85		6 45	4711 8
STD	0010	-01 89	34 57	27 85	0 003	6 49	4711 8
OBS	0010	-01 89	34 57	27 85		6 49	4711 8
STD	0020	-01 90	34 61	27 88	0 006	6 46	4712 4
OBS	0020	-01 90	34 61	27 88		6 46	4712 4
STD	0030	-01 92	34 57	27 85	0 008	6 46	4712 5
OBS	0030	-01 92	34 57	27 85		6 46	4712 5
STD	0050	-01 92	34 57	27 85	0 013	6 41	4713 7
OBS	0050	-01 92	34 57	27 85		6 41	4713 7
STD	0075	-01 90	34 59	27 87	0 019	6 34	4715 6
OBS	0075	-01 90	34 59	27 87		6 34	4715 6
STD	0100	-01 86	34 62	27 89	0 025	6 23	4717 8
OBS	0100	-01 86	34 62	27 89		6 23	4717 8
STD	0150	-01 87	34 70	27 96	0 034	6 23	4721 0
OBS	0150	-01 87	34 70	27 96		6 23	4721 0
STD	0200	-01 90	34 73	27 98	0 041	6 13	4723 6
OBS	0200	-01 90	34 73	27 98		6 13	4723 6
STD	0250	-01 92	34 74	27 99	0 047	6 09	4726 3
OBS	0250	-01 92	34 74	27 99		6 09	4726 3
STD	0300	-01 88	34 86	28 09	0 051	5 86	4730 4
OBS	0300	-01 88	34 86	28 09		5 86	4730 4
OBS	0350	-01 90	34 78	28 02		5 90	4732 7
STD	0400	-01 88	34 81	28 05	0 054	5 87	4736 2
OBS	0400	-01 88	34 81	28 05			4736 2
OBS	0450	-01 84*	34 79	28 03*		5 84	4739 7*
STD	0500	-01 90	34 79	28 03	0 060	5 98	4741 7
OBS	0500	-01 90	34 79	28 03		5 98	4741 7
OBS	0550	-01 92	34 78	28 02		6 06	4744 3
OBS	0562	-01 90	34 80	28 04		6 06	4745 4

SURFACE OBSERVATIONS									
NODC REF. NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0005	06	16	1960	23	77° 53 S	166 44 E	0566	06

WIND		ANEMO. HGT	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR	AMT	DIR	AMT		COL	TRANS.
01	27		88	75 0					0							16

SUBSURFACE OBSERVATIONS							
	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 66	34 59	27 86	0 000	6 33	4714 9
OBS	0000	-01 66	34 59	27 86		6 33	4714 9
OBS	0005	-01 90	34 60	27 88		6 37	4711 4
STD	0010	-01 88	34 60	27 88	0 002	6 36	4712 1
OBS	0010	-01 88	34 60	27 88		6 36	4712 1
STD	0020	-01 91	34 60	27 88	0 005	6 33	4712 2
OBS	0020	-01 91	34 60	27 88		6 33	4712 2
STD	0030	-01 94	34 60	27 88	0 007	6 32	4712 3
OBS	0030	-01 94	34 60	27 88		6 32	4712 3
STD	0050	-01 93	34 60	27 88	0 012	6 31	4713 6
OBS	0050	-01 93	34 60	27 88		6 31	4713 6
STD	0075	-01 89	34 66	27 92	0 017	6 13	4716 0
OBS	0075	-01 89	34 66	27 92		6 13	4716 0
STD	0100	-01 88	34 68	27 94	0 021	6 13	4717 8
OBS	0100	-01 88	34 68	27 94		6 13	4717 8
STD	0150	-01 86	34 71	27 96	0 029	6 06	4721 2
OBS	0150	-01 86	34 71	27 96		6 06	4721 2
STD	0200	-01 89	34 72	27 97	0 036	6 15	4723 7
OBS	0200	-01 89	34 72	27 97		6 15	4723 7
STD	0250	-01 90	34 73	27 98	0 043	6 07	4726 6
OBS	0250	-01 90	34 73	27 98		6 07	4726 6
STD	0300	-01 89	34 76	28 01	0 048	5 96	4729 8
OBS	0300	-01 89	34 76	28 01		5 96	4729 8
OBS	0350	-01 89	34 77	28 01		5 82	4732 9
STD	0400	-01 89	34 80	28 04	0 056	5 92	4736 0
OBS	0400	-01 89	34 80	28 04		5 92	4736 0
OBS	0450	-01 87	34 78	28 02		5 97	4739 2
STD	0500	-01 89	34 79	28 03	0 062	6 04	4741 9
OBS	0500	-01 89	34 79	28 03		6 04	4741 9
OBS	0550	-01 92	34 81	28 05		6 04	4744 5
OBS	0562	-01 92	34 80	28 04		6 05	4745 1

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE MO	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0006	06	26	1960	23	77° 53' S	166° 44' E	0566	06

WIND SPEED	WIND DIR.	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS.
01	14			74 5			01									

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 90	34 65	27 92	0 000	6 20	4711 4
OBS	0000	-01 90	34 65	27 92		6 20	4711 4
OBS	0005	-01 89	34 64	27 91		6 22	4711 8
STD	0010	-01 88	34 64	27 91	0 002	6 18	4712 2
OBS	0010	-01 88	34 64	27 91		6 18	4712 2
STD	0020	-01 91	34 65	27 92	0 004	6 24	4712 4
OBS	0020	-01 91	34 65	27 92		6 24	4712 4
STD	0030	-01 91	34 65	27 92	0 006	6 24	4713 0
OBS	0030	-01 91	34 65	27 92		6 24	4713 0
STD	0050	-01 91	34 65	27 92	0 010	6 24	4714 2
OBS	0050	-01 91	34 65	27 92		6 24	4714 2
STD	0075	-01 91	34 67	27 93	0 015	6 21	4715 8
OBS	0075	-01 91	34 67	27 93		6 21	4715 8
STD	0100	-01 87	34 66	27 92	0 019	6 23	4717 8
OBS	0100	-01 87	34 66	27 92		6 23	4717 8
STD	0150	-01 88	34 70	27 96	0 027	6 16	4720 8
OBS	0150	-01 88	34 70	27 96		6 16	4720 8
STD	0200	-01 90	34 75	28 00	0 034	6 08	4723 7
OBS	0200	-01 90	34 75	28 00		6 08	4723 7
STD	0250	-01 91	34 75	28 00	0 039	6 07	4726 5
OBS	0250	-01 91	34 75	28 00		6 07	4726 5
STD	0300	-01 91	34 76	28 01	0 044	6 09	4729 5
OBS	0300	-01 91	34 76	28 01		6 09	4729 5
OBS	0350	-01 90	34 79	28 03		5 93	4732 8
STD	0400	-01 89	34 79	28 03	0 053	5 92	4735 9
OBS	0400	-01 89	34 79	28 03		5 92	4735 9
OBS	0450	-01 87	34 80	28 04		5 92	4739 3
STD	0500	-01 89	34 80	28 04	0 059	5 99	4741 9
OBS	0500	-01 89	34 80	28 04		5 99	4741 9
OBS	0550	-01 91	34 80	28 04		6 02	4744 6
OBS	0562	-01 90	34 80	28 04		6 03	4745 4

SURFACE OBSERVATIONS

NODC REF NO	STATION	DATE MO	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE ° '	POSITION LONGITUDE ° '	SONIC DEPTH UNCORRECTED	MAX SAMPLE DEPTH
00598	0007	07	10	1960	01	77 53 S	166 44 E	0566	06

WIND SPEED	WIND DIR	ANEMO HGT	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS	WATER COL.	WATER TRANS.
01	18		87	73 3			02									12

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 67	34 66	27 92	0 000	6 28	4715 1
OBS	0000	-01 67	34 66	27 92		6 28	4715 1
OBS	0005	-01 90	34 65	27 92		6 28	4711 7
STD	0010	-01 89	34 66	27 92	0 002	6 25	4712 2
OBS	0010	-01 89	34 66	27 92		6 25	4712 2
STD	0020	-01 92	34 66	27 93	0 004	6 23	4712 3
OBS	0020	-01 92	34 66	27 93		6 23	4712 3
STD	0030	-01 93	34 65	27 92	0 006	6 23	4712 7
OBS	0030	-01 93	34 65	27 92		6 23	4712 7
STD	0050	-01 93	34 68	27 94	0 009	6 18	4714 0
OBS	0050	-01 93	34 68	27 94		6 18	4714 0
STD	0075	-01 91	34 71	27 97	0 013	6 14	4715 9
OBS	0075	-01 91	34 71	27 97		6 14	4715 9
STD	0100	-01 89	34 72	27 97	0 017	6 16	4717 8
OBS	0100	-01 89	34 72	27 97		6 16	4717 8
STD	0150	-01 88	34 73	27 98	0 024	6 15	4721 0
OBS	0150	-01 88	34 73	27 98		6 15	4721 0
STD	0200	-01 90	34 75	28 00	0 030	6 15	4723 7
OBS	0200	-01 90	34 75	28 00		6 15	4723 7
STD	0250	-01 91	34 76	28 01	0 035	6 10	4726 5
OBS	0250	-01 91	34 76	28 01		6 10	4726 5
STD	0300	-01 91	34 78	28 02	0 039	6 08	4729 6
OBS	0300	-01 91	34 78	28 02		6 08	4729 6
OBS	0350	-01 90	34 79	28 03		6 13	4732 8
STD	0400	-01 90	34 80	28 04	0 046	6 16	4735 8
OBS	0400	-01 90	34 80	28 04		6 16	4735 8
OBS	0450	-01 89	34 80	28 04		6 11	4738 9
STD	0500	-01 90	34 80	28 04	0 052	6 18	4741 8
OBS	0500	-01 90	34 80	28 04		6 18	4741 8
OBS	0550	-01 92	34 80	28 04		6 16	4744 4
OBS	0562	-01 91	34 81	28 05		5 90	4745 3

SURFACE OBSERVATIONS

NODC REF NO.	STATION	DATE MO.	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0008	07	20	1960	24	77° 53' S	166° 44' E	0566	06

WIND SPEED	WIND DIR	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS.
06	09			55 5					0							15

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S‰	σ_t	$\Sigma\Delta D$	O_2 ml/l	V_f
STD	0000	-01 59	34 68	27 93	0 000	6 09	4716 4
OBS	0000	-01 59	34 68	27 93		6 09	4716 4
OBS	0005	-01 88	34 68	27 94		6 14	4712 1
STD	0010	-01 89	34 69	27 95	0 002	6 09	4712 3
OBS	0010	-01 89	34 69	27 95		6 09	4712 3
STD	0020	-01 91	34 69	27 95	0 003	6 05	4712 6
OBS	0020	-01 91	34 69	27 95		6 05	4712 6
STD	0030	-01 92	34 71	27 97	0 005	6 04	4713 1
OBS	0030	-01 92	34 71	27 97		6 04	4713 1
STD	0050	-01 91	34 68	27 94	0 008	6 03	4714 3
OBS	0050	-01 91	34 68	27 94		6 03	4714 3
STD	0075	-01 90	34 72	27 97	0 012	6 02	4716 1
OBS	0075	-01 90	34 72	27 97		6 02	4716 1
STD	0100	-01 89	34 73	27 98	0 015	6 04	4717 8
OBS	0100	-01 89	34 73	27 98		6 04	4717 8
STD	0150	-01 88	34 74	27 99	0 022	6 02	4721 0
OBS	0150	-01 88	34 74	27 99		6 02	4721 0
STD	0200	-01 91	34 75	28 00	0 027	6 02	4723 5
OBS	0200	-01 91	34 75	28 00		6 02	4723 5
STD	0250	-01 92	34 77	28 02	0 033	6 01	4726 4
OBS	0250	-01 92	34 77	28 02		6 01	4726 4
STD	0300	-01 91	34 77	28 01	0 037	6 03	4729 6
OBS	0300	-01 91	34 77	28 01		6 03	4729 6
OBS	0350	-01 90	34 78	28 02		5 96	4732 7
STD	0400	-01 89	34 83	28 06	0 043	5 99	4736 1
OBS	0400	-01 89	34 83	28 06		5 99	4736 1
OBS	0450	-01 87	34 81	28 05		5 91	4739 3
STD	0500	-01 90	34 81	28 05	0 048	5 89	4741 8
OBS	0500	-01 90	34 81	28 05		5 89	4741 8
OBS	0550	-01 90	34 83	28 06		5 88	4744 9
OBS	0562	-01 90	34 84	28 07		5 86	4745 6

SURFACE OBSERVATIONS								
NODC REF NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0009	07	29	1960	24	77° 53′ S	166° 44′ E	0566	06

WIND		ANEMO HGT	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR	AMT	DIR	AMT.		COL.	TRANS.
01	09			51 7			02		6							

SUBSURFACE OBSERVATIONS							
	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 52	34 65	27 91	0 000	6 16	4717 4
OBS	0000	-01 52	34 65	27 91		6 16	4717 4
OBS	0005	-01 88	34 67	27 93		6 21	4712 1
STD	0010	-01 88	34 67	27 93	0 002	6 20	4712 4
OBS	0010	-01 88	34 67	27 93		6 20	4712 4
STD	0020	-01 91	34 68	27 94	0 004	6 21	4712 5
OBS	0020	-01 91	34 68	27 94		6 21	4712 5
STD	0030	-01 92	34 68	27 94	0 005	6 21	4713 0
OBS	0030	-01 92	34 68	27 94		6 21	4713 0
STD	0050	-01 93	34 69	27 95	0 009	6 20	4714 0
OBS	0050	-01 93	34 69	27 95		6 20	4714 0
STD	0075	-01 91	34 71	27 97	0 013	6 13	4715 9
OBS	0075	-01 91	34 71	27 97		6 13	4715 9
STD	0100	-01 90	34 72	27 97	0 016	6 14	4717 6
OBS	0100	-01 90	34 72	27 97		6 14	4717 6
STD	0150	-01 88	34 74	27 99	0 023	6 17	4721 0
OBS	0150	-01 88	34 74	27 99		6 17	4721 0
STD	0200	-01 91	34 76	28 01	0 028	6 14	4723 6
OBS	0200	-01 91	34 76	28 01		6 14	4723 6
STD	0250	-01 92	34 77	28 02	0 033	6 12	4726 4
OBS	0250	-01 92	34 77	28 02		6 12	4726 4
STD	0300	-01 91	34 77	28 01	0 038	6 18	4729 6
OBS	0300	-02 04*	34 77	28 02*		6 18	4727 5*
OBS	0350	-01 90	34 77	28 01		6 18	4732 7
STD	0400	-01 90	34 77	28 01	0 046	6 19	4735 7
OBS	0400	-01 90	34 77	28 01		6 19	4735 7
OBS	0450	-01 88	34 79	28 03		6 10	4739 1
STD	0500	-01 90	34 80	28 04	0 053	6 12	4741 8
OBS	0500	-01 90	34 80	28 04		6 12	4741 8
OBS	0550	-01 91	34 81	28 05		6 12	4744 6
OBS	0562	-01 91	34 82	28 06		6 16	4745 4

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0010	08	22	1960	03	77° 53′ S	166° 44′ E	0576	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMID-ITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT	DIR	AMT.		COL.	TRANS
00	00		91	51 1			00		0							

SUBSURFACE OBSERVATIONS							
	SAMPLE DEPTH (M)	T °C	S‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 84	34 64	27 91	0 000	6 14	4712 3
OBS	0000	-01 84	34 64	27 91		6 14	4712 3
OBS	0005	-01 89	34 72	27 97		6 16	4712 1
STD	0010	-01 91	34 73	27 98	0 002	6 15	4712 1
OBS	0010	-01 91	34 73	27 98		6 15	4712 1
STD	0020	-01 92	34 74	27 99	0 003	6 17	4712 6
OBS	0020	-01 92	34 74	27 99		6 17	4712 6
STD	0030	-01 92	34 73	27 98	0 004	6 13	4713 2
OBS	0030	-01 92	34 73	27 98		6 13	4713 2
STD	0050	-01 92	34 74	27 99	0 007	6 15	4714 4
OBS	0050	-01 92	34 74	27 99		6 15	4714 4
STD	0075	-01 90	34 74	27 99	0 010	6 12	4716 2
OBS	0075	-01 90	34 74	27 99		6 12	4716 2
STD	0100	-01 88	34 76	28 01	0 013	6 12	4718 1
OBS	0100	-01 88	34 76	28 01		6 12	4718 1
STD	0150	-01 88	34 76	28 01	0 018	6 11	4721 1
OBS	0150	-01 88	34 76	28 01		6 11	4721 1
STD	0200	-01 90	34 77	28 01	0 023	6 10	4723 8
OBS	0200	-01 90	34 77	28 01		6 10	4723 8
STD	0250	-01 92	34 78	28 02	0 028	6 10	4726 5
OBS	0250	-01 92	34 78	28 02		6 10	4726 5
STD	0300	-01 90	34 80	28 04	0 031	6 14	4729 9
OBS	0300	-01 90	34 80	28 04		6 14	4729 9
OBS	0350	-01 91	34 81	28 05		6 87	4732 7
STD	0400	-01 88	34 82	28 05	0 037	6 13	4736 2
OBS	0400	-01 88	34 82	28 05		6 13	4736 2
OBS	0450	-01 86	34 81	28 05		6 14	4739 5
STD	0500	-01 91	34 83	28 06	0 041	6 18	4741 7
OBS	0500	-01 91	34 83	28 06		6 18	4741 7
OBS	0550	-01 92	34 84	28 07		6 18	4744 6
OBS	0562	-01 92	34 84	28 07		6 19	4745 3

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE MO	DAY	YEAR	HOUR	POSITION LATITUDE	LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0011	08	31	1960	00	77° 53' S	166° 44' E	0566	06

WIND SPEED	WIND DIR	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR	SEA AMT	SWELL DIR	SWELL AMT.	VIS	WATER COL.	WATER TRANS
10	18		68	68 3			75							0		

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 86	34 70	27 96	0 000	5 89	4712 2
OBS	0000	-01 86	34 70	27 96		5 89	4712 2
OBS	0005	-01 92	34 72	27 97		5 92	4711 6
STD	0010	-01 91	34 71	27 97	0 002	5 93	4712 1
OBS	0010	-01 91	34 71	27 97		5 93	4712 1
STD	0020	-01 94	34 72	27 97	0 003	5 95	4712 2
OBS	0020	-01 94	34 36*	28 09*		5 95	4712 8*
STD	0030	-01 94	34 72	27 97	0 004	5 93	4712 8
OBS	0030	-01 94	34 72	27 97		5 93	4712 8
STD	0050	-01 96	34 72	27 98	0 007	5 96	4713 7
OBS	0050	-01 96	34 72	27 98		5 96	4713 7
STD	0075	-01 94	34 74	27 99	0 011	5 88	4715 6
OBS	0075	-01 94	34 74	27 99		5 88	4715 6
STD	0100	-01 92	34 76	28 01	0 013	5 87	4717 5
OBS	0100	-01 92	34 76	28 01		5 87	4717 5
STD	0150	-01 90	34 77	28 01	0 019	5 87	4720 8
OBS	0150	-01 90	34 77	28 01		5 87	4720 8
STD	0200	-01 92	34 79	28 03	0 023	5 88	4723 6
OBS	0200	-01 92	34 79	28 03		5 88	4723 6
STD	0250	-01 92	34 78	28 02	0 027	5 88	4726 5
OBS	0250	-01 92	34 78	28 02		5 88	4726 5
STD	0300	-01 92	34 79	28 03	0 031	5 91	4729 5
OBS	0300	-01 92	34 79	28 03		5 91	4729 5
OBS	0350	-01 92	34 79	28 03		5 86	4732 5
STD	0400	-01 90	34 83	28 06	0 036	5 83	4735 9
OBS	0400	-01 90	34 83	28 06		5 83	4735 9
OBS	0450	-01 89	34 82	28 05		5 86	4739 0
STD	0500	-01 90	34 85	28 08	0 039	5 85	4742 0
OBS	0500	-01 90	34 85	28 08		5 85	4742 0
OBS	0550	-01 92	34 84	28 07		5 88	4744 6
OBS	0562	-01 91	34 85	28 08		5 88	4745 5

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE MO.	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0012	09	09	1960	23	77° 53' S	166° 44' E	0565	06

WIND SPEED	WIND DIR.	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMID-ITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS
03	32		62	81 7			75									

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 42	34 63	27 89	0 000	5 91	4718 9
OBS	0000	-01 42	34 63	27 89		5 91	4718 9
OBS	0005	-01 91	34 75	28 00		5 86	4711 9
STD	0010	-01 90	34 74	27 99	0 002	5 84	4712 4
OBS	0010	-01 90	34 74	27 99		5 84	4712 4
STD	0020	-01 92	34 79	28 03	0 003	5 83	4712 8
OBS	0020	-01 92	34 79	28 03		5 83	4712 8
STD	0030	-01 93	34 74	27 99	0 004	5 87	4713 1
OBS	0030	-01 93	34 74	27 99		5 87	4713 1
STD	0050	-01 94	34 76	28 01	0 006	5 90	4714 2
OBS	0050	-01 94	34 76	28 01		5 90	4714 2
STD	0075	-01 93	34 76	28 01	0 009	5 83	4715 8
OBS	0075	-01 93	34 76	28 01		5 83	4715 8
STD	0100	-01 90	34 80	28 04	0 011	5 86	4718 0
OBS	0100	-01 90	34 80	28 04		5 86	4718 0
STD	0150	-01 88	34 78	28 02	0 016	5 85	4721 2
OBS	0150	-01 88	34 78	28 02		5 85	4721 2
STD	0200	-01 90	34 78	28 02	0 020	5 88	4723 8
OBS	0200	-01 90	34 78	28 02		5 88	4723 8
STD	0250	-01 92	34 81	28 05	0 024	5 83	4726 6
OBS	0250	-01 92	34 81	28 05		5 83	4726 6
STD	0300	-01 89	34 81	28 05	0 027	5 83	4730 1
OBS	0300	-01 89	34 81	28 05		5 83	4730 1
OBS	0350	-01 91	34 82	28 06		5 78	4732 8
STD	0400	-01 90	34 84	28 07	0 031	5 82	4736 0
OBS	0400	-01 90	34 84	28 07		5 82	4736 0
OBS	0450	-01 88	34 85	28 08		5 82	4739 3
STD	0500	-01 91	34 86	28 09	0 033	5 85	4741 9
OBS	0500	-01 91	34 86	28 09		5 85	4741 9
OBS	0550	-01 91	34 85	28 08		5 90	4744 8
OBS	0562	-01 90	34 86	28 09		5 94	4745 7

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE MO.	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0013	09	20	1960	23	77° 53' S	166° 44' E	0566	06

WIND SPEED	WIND DIR.	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS.
	14		84	75 0			36									

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 89	34 71	27 97	0 000	5 82	4711 8
OBS	0000	-01 89	34 71	27 97		5 82	4711 8
OBS	0005	-01 92	34 73	27 98		5 90	4711 7
STD	0010	-01 91	34 73	27 98	0 001	5 87	4712 1
OBS	0010	-01 91	34 73	27 98		5 87	4712 1
STD	0020	-01 94	34 75	28 00	0 003	5 84	4712 4
OBS	0020	-01 94	34 75	28 00		5 84	4712 4
STD	0030	-01 94	34 70	27 96	0 004	5 85	4712 7
OBS	0030	-01 94	34 70	27 96		5 85	4712 7
STD	0050	-01 94	34 73	27 98	0 007	5 89	4714 0
OBS	0050	-01 94	34 73	27 98		5 89	4714 0
STD	0075	-01 94	34 73	27 98	0 010	5 86	4715 5
OBS	0075	-01 94	34 73	27 98		5 86	4715 5
STD	0100	-01 90	34 76	28 01	0 013	5 91	4717 8
OBS	0100	-01 90	34 76	28 01		5 91	4717 8
STD	0150	-01 90	34 78	28 02	0 018	5 85	4720 8
OBS	0150	-01 90	34 78	28 02		5 85	4720 8
STD	0200	-01 92	34 79	28 03	0 022	5 88	4723 6
OBS	0200	-01 92	34 79	28 03		5 88	4723 6
STD	0250	-01 93	34 78	28 02	0 026	5 88	4726 3
OBS	0250	-01 93	34 78	28 02		5 88	4726 3
STD	0300	-01 91	34 81	28 05	0 030	5 84	4729 7
OBS	0300	-01 91	34 81	28 05		5 84	4729 7
OBS	0350	-01 91	34 82	28 06		5 82	4732 8
STD	0400	-01 90	34 82	28 06	0 035	5 81	4735 9
OBS	0400	-01 90	34 82	28 06		5 81	4735 9
OBS	0450	-01 88	34 84	28 07		5 81	4739 3
STD	0500	-01 90	34 85	28 08	0 038	5 77	4742 0
OBS	0500	-01 90	34 85	28 08		5 77	4742 0
OBS	0550	-01 90	34 86	28 09		5 76	4745 0
OBS	0562	-01 90	34 86	28 09		5 81	4745 7

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0014	10	02	1960	03	77° 53' S	166° 44' E	0566	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS
00			98	80 5			02		0							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 83	34 47	27 77	0 000	5 18	4711 7
OBS	0000	-01 83	34 47	27 77		5 18	4711 7
OBS	0005	-01 92	34 74	27 99		5 91	4711 7
STD	0010	-01 90	34 73	27 98	0 002	5 92	4712 3
OBS	0010	-01 90	34 73	27 98		5 92	4712 3
STD	0020	-01 94	34 73	27 98	0 004	5 85	4712 3
OBS	0020	-01 94	34 73	27 98		5 85	4712 3
STD	0030	-01 94	34 70	27 96	0 005	5 87	4712 7
OBS	0030	-01 94	34 70	27 96		5 87	4712 7
STD	0050	-01 92	34 74	27 99	0 008	5 89	4714 4
OBS	0050	-01 92	34 74	27 99		5 89	4714 4
STD	0075	-01 94	34 76	28 01	0 011	5 81	4715 7
OBS	0075	-01 94	34 76	28 01		5 81	4715 7
STD	0100	-01 93	34 77	28 02	0 014	5 87	4717 4
OBS	0100	-01 93	34 77	28 02		5 87	4717 4
STD	0150	-01 90	34 81	28 05	0 018	5 82	4721 0
OBS	0150	-01 90	34 81	28 05		5 82	4721 0
STD	0200	-01 92	34 81	28 05	0 021	5 82	4723 6
OBS	0200	-01 92	34 81	28 05		5 82	4723 6
STD	0250	-01 93	34 80	28 04	0 024	5 83	4726 4
OBS	0250	-01 93	34 80	28 04		5 83	4726 4
STD	0300	-01 88	34 82	28 05	0 027	5 87	4730 3
OBS	0300	-01 88	34 82	28 05		5 87	4730 3
OBS	0350	-01 91	34 82	28 06		5 80	4732 8
STD	0400	-01 91	34 82	28 06	0 032	5 87	4735 7
OBS	0400	-01 91	34 82	28 06		5 87	4735 7
OBS	0450	-01 88	34 83	28 06		5 84	4739 2
STD	0500	-01 90	34 86	28 09	0 035	5 90	4742 0
OBS	0500	-01 90	34 86	28 09		5 90	4742 0
OBS	0550	-01 93	34 86	28 09		5 88	4744 5
OBS	0562	-01 89	34 88	28 10		5 91	4746 0

SURFACE OBSERVATIONS									
NODC REF NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0015	10	12	1960	23	77° 53' S	166° 44' E	0575	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMID-ITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
02	00		80	66 0					9							

	SUBSURFACE OBSERVATIONS						
	SAMPLE DEPTH (M)	T °C	S‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 48	34 71	27 95	0 000	5 84	4718 3
OBS	0000	-01 48	34 71	27 95		5 84	4718 3
OBS	0005	-01 93	34 73	27 98		5 83	4711 5
STD	0010	-01 92	34 76	28 01	0 001	5 86	4712 1
OBS	0010	-01 92	34 76	28 01		5 86	4712 1
STD	0020	-01 92	34 73	27 98	0 003	5 90	4712 6
OBS	0020	-01 92	34 73	27 98		5 90	4712 6
STD	0030	-01 97	34 73	27 98	0 004	5 84	4712 4
OBS	0030	-01 97	34 73	27 98		5 84	4712 4
STD	0050	-01 94	34 78	28 02	0 006	5 92	4714 3
OBS	0050	-01 94	34 78	28 02		5 92	4714 3
STD	0075	-01 94	34 72	27 97	0 009	5 90	4715 5
OBS	0075	-01 94	34 72	27 97		5 90	4715 5
STD	0100	-01 95	34 73	27 98	0 012	5 93	4716 9
OBS	0100	-01 95	34 73	27 98		5 93	4716 9
STD	0150	-01 90	34 77	28 01	0 018	5 84	4720 8
OBS	0150	-01 90	34 77	28 01		5 84	4720 8
STD	0200	-01 92	34 80	28 04	0 022	5 80	4723 6
OBS	0200	-01 92	34 80	28 04		5 80	4723 6
STD	0250	-01 94	34 80	28 04	0 026	5 84	4726 2
OBS	0250	-01 94	34 80	28 04		5 84	4726 2
STD	0300	-01 91	34 83	28 06	0 029	5 84	4729 8
OBS	0300	-01 91	34 83	28 06		5 84	4729 8
OBS	0350	-01 92	34 83	28 06		5 80	4732 6
STD	0400	-01 92	34 87	28 10	0 031	5 90	4735 8
OBS	0400	-01 92	34 87	28 10		5 90	4735 8
OBS	0450	-01 88	34 87	28 10		5 83	4739 4
STD	0500	-01 91	34 87	28 10	0 031	5 72	4741 9
OBS	0500	-01 91	34 87	28 10		5 72	4741 9
OBS	0550	-01 94	35 02*	28 22*		5 86	4745 1*
OBS	0562	-01 90	34 88	28 10		5 76	4745 8
OBS	0575	-01 91	34 87	28 10		5 90	4746 4

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE MO.	DAY	YEAR	HOUR	POSITION LATITUDE	LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0016	10	23	1960	23	77° 53' S	166° 44' E	0579	06

WIND SPEED	WIND DIR.	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT	SWELL DIR	SWELL AMT.	VIS	WATER COL.	WATER TRANS.
05	14			62 0			73		9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 29	34 73	27 96	0 000	5 76	4721 3
OBS	0000	-01 29	34 73	27 96		5 76	4721 3
OBS	0005	-01 91	34 76	28 01		5 80	4712 0
STD	0010	-01 90	34 76	28 01	0 001	5 84	4712 4
OBS	0010	-01 90	34 76	28 01		5 84	4712 4
STD	0020	-01 94	34 80	28 04	0 002	5 84	4712 6
OBS	0020	-01 94	34 80	28 04		5 84	4712 6
STD	0030	-01 94	34 74	27 99	0 003	5 80	4712 9
OBS	0030	-01 94	34 74	27 99		5 80	4712 9
STD	0050	-01 96	34 74	27 99	0 006	5 88	4713 8
OBS	0050	-01 96	34 74	27 99		5 88	4713 8
STD	0075	-01 94	34 75	28 00	0 009	5 82	4715 6
OBS	0075	-01 94	34 75	28 00		5 82	4715 6
STD	0100	-01 96	34 77	28 02	0 012	5 86	4716 9
OBS	0100	-01 96	34 77	28 02		5 86	4716 9
STD	0150	-01 90	34 81	28 05	0 016	5 82	4721 0
OBS	0150	-01 90	34 81	28 05		5 82	4721 0
STD	0200	-01 92	34 83	28 06	0 018	5 83	4723 7
OBS	0200	-01 92	34 83	28 06		5 83	4723 7
STD	0250	-01 92	34 84	28 07	0 021	5 82	4726 7
OBS	0250	-01 92	34 84	28 07		5 82	4726 7
STD	0300	-01 86	34 83	28 06	0 023	5 88	4730 6
OBS	0300	-01 86	34 83	28 06		5 88	4730 6
OBS	0350	-01 91	34 84	28 07		5 83	4732 8
STD	0400	-01 91	34 86	28 09	0 026	5 79	4735 9
OBS	0400	-01 91	34 86	28 09		5 79	4735 9
OBS	0450	-01 88	34 85	28 08		5 82	4739 3
STD	0500	-01 90	34 87	28 10	0 026	5 91	4742 1
OBS	0500	-01 90	34 87	28 10		5 91	4742 1
OBS	0550	-01 92	34 87	28 10		5 91	4744 7
OBS	0575	-01 93	34 89	28 11		5 88	4746 1

SURFACE OBSERVATIONS

NODC REF NO	STATION	DATE MO	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX SAMPLE DEPTH
00598	0017	11	07	1960	02	77° 52 S	166° 44 E	0576	06

WIND SPEED	WIND DIR	ANEMO HGT	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT	SWELL DIR	SWELL AMT.	VIS.	WATER COL.	WATER TRANS.
02	09		85	68 0					0							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_t
STD	0000	-01 90	34 77	28 01	0 000	5 70	4711 9
OBS	0000	-01 90	34 77	28 01		5 70	4711 9
OBS	0005	-01 91	34 76	28 01		5 68	4712 0
STD	0010	-01 90	34 76	28 01	0 001	5 77	4712 4
OBS	0010	-01 90	34 76	28 01		5 77	4712 4
STD	0020	-01 94	34 79	28 03	0 002	5 77	4712 5
OBS	0020	-01 94	34 79	28 03		5 77	4712 5
STD	0030	-01 94	34 78	28 02	0 003	5 78	4713 1
OBS	0030	-01 94	34 78	28 02		5 78	4713 1
STD	0050	-01 91	34 79	28 03	0 005	5 67	4714 8
OBS	0050	-01 91	34 79	28 03		5 67	4714 8
STD	0075	-01 92	34 81	28 05	0 007	5 76	4716 2
OBS	0075	-01 92	34 81	28 05		5 76	4716 2
STD	0100	-01 91	34 81	28 05	0 009	5 76	4717 8
OBS	0100	-01 91	34 81	28 05		5 76	4717 8
STD	0150	-01 90	34 85	28 08	0 011	5 69	4721 2
OBS	0150	-01 90	34 85	28 08		5 69	4721 2
STD	0200	-01 92	34 83	28 06	0 013	5 70	4723 7
OBS	0200	-01 92	34 83	28 06		5 70	4723 7
STD	0250	-01 92	34 84	28 07	0 015	5 74	4726 7
OBS	0250	-01 92	34 84	28 07		5 74	4726 7
STD	0300	-01 89	34 94	28 15	0 015	5 77	4730 6
OBS	0300	-01 89	34 94	28 15		5 77	4730 6
OBS	0350	-01 91	34 78	28 02		5 72	4732 6
STD	0400	-01 90	34 80	28 04	0 016	5 82	4735 8
OBS	0400	-01 90	34 80	28 04		5 82	4735 8
OBS	0450	-01 88	34 81	28 05		5 76	4739 1
STD	0500	-01 90	34 85	28 08	0 020	5 80	4742 0
OBS	0500	-01 90	34 85	28 08		5 80	4742 0
OBS	0550	-01 93	34 85	28 08		5 80	4744 5
OBS	0575	-01 90	34 91	28 13		5 84	4746 7

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE MO.	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0018	11	18	1960	23	77° 53' S	166° 44' E	0576	06

WIND SPEED	WIND DIR.	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS
00				61 0					0							10

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S‰	σ_t	ΣΔD	O_2 ml/l	V_f
STD	0000	-01 82	34 71	27 96	0 000	5 78	4712 9
OBS	0000	-01 82	34 71	27 96		5 78	4712 9
OBS	0005	-01 90	34 71	27 97		5 83	4711 9
STD	0010	-01 88	34 70	27 96	0 002	5 91	4712 5
OBS	0010	-01 88	34 70	27 96		5 91	4712 5
STD	0020	-01 92	34 70	27 96	0 003	5 91	4712 5
OBS	0020	-01 92	34 70	27 96		5 91	4712 5
STD	0030	-01 92	34 70	27 96	0 005	5 86	4713 1
OBS	0030	-01 92	34 70	27 96		5 86	4713 1
STD	0050	-01 92	34 70	27 96	0 008	5 86	4714 2
OBS	0050	-01 70*	34 70	27 95*		5 86	4717 7*
STD	0075	-01 92	34 71	27 97	0 012	5 91	4715 8
OBS	0075	-01 92	34 71	27 97		5 91	4715 8
STD	0100	-01 91	34 71	27 97	0 015	5 87	4717 4
OBS	0100	-01 91	34 71	27 97		5 87	4717 4
STD	0150	-01 90	34 72	27 97	0 022	5 81	4720 6
OBS	0150	-01 90	34 72	27 97		5 81	4720 6
STD	0200	-01 92	34 75	28 00	0 028	5 82	4723 4
OBS	0200	-01 92	34 75	28 00		5 82	4723 4
STD	0250	-01 94	34 76	28 01	0 034	5 81	4726 1
OBS	0250	-01 94	34 76	28 01		5 81	4726 1
STD	0300	-01 95	34 83	28 06	0 037	5 84	4729 2
OBS	0300	-01 95	34 83	28 06		5 84	4729 2
OBS	0350	-01 91	34 79	28 03		5 84	4732 6
STD	0400	-01 90	34 79	28 03	0 043	5 85	4735 8
OBS	0400	-01 90	34 79	28 03		5 85	4735 8
OBS	0450	-01 86	34 80	28 04		5 88	4739 4
STD	0500	-01 89	34 80	28 04	0 049	5 86	4741 9
OBS	0500	-01 89	34 80	28 04		5 86	4741 9
OBS	0550	-01 92	34 83	28 06		5 92	4744 5
OBS	0575	-01 90	34 83	28 06		6 01	4746 4

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0019	11	29	1960	23	77° 53′ S	166° 44′ E	0585	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMID-ITY	WEATHER	CLOUD		SEA		SWELL		VIS	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR	AMT	DIR	AMT		COL.	TRANS.
04	09			55 1					0							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S % O	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 65	34 76	28 00	0 000	5 48	4715 8
OBS	0000	-01 65	34 76	28 00		5 48	4715 8
OBS	0005	-01 91	34 78	28 02		5 63	4712 1
STD	0010	-01 90	34 77	28 01	0 001	5 69	4712 5
OBS	0010	-01 90	34 77	28 01		5 69	4712 5
STD	0020	-01 92	34 77	28 02	0 002	5 61	4712 8
OBS	0020	-01 92	34 77	28 02		5 61	4712 8
STD	0030	-01 93	34 77	28 02	0 003	5 63	4713 2
OBS	0030	-01 93	34 77	28 02		5 63	4713 2
STD	0050	-01 94	34 79	28 03	0 005	5 62	4714 3
OBS	0050	-01 94	34 79	28 03		5 62	4714 3
STD	0075	-01 94	34 78	28 02	0 007	5 69	4715 8
OBS	0075	-01 94	34 78	28 02		5 69	4715 8
STD	0100	-01 94	34 80	28 04	0 009	5 68	4717 3
OBS	0100	-01 94	34 80	28 04		5 68	4717 3
STD	0150	-01 90	34 81	28 05	0 013	5 68	4721 0
OBS	0150	-01 90	34 81	28 05		5 68	4721 0
STD	0200	-01 92	34 82	28 06	0 016	5 75	4723 7
OBS	0200	-01 92	34 82	28 06		5 75	4723 7
STD	0250	-01 94	34 87	28 10	0 018	5 67	4726 6
OBS	0250	-01 94	34 87	28 10		5 67	4726 6
STD	0300	-01 88	34 84	28 07	0 019	5 74	4730 4
OBS	0300	-01 88	34 84	28 07		5 74	4730 4
OBS	0350	-01 89	34 87	28 10		5 76	4733 3
STD	0400	-01 88	34 89	28 11	0 020	5 54	4736 5
OBS	0400	-01 88				5 54	
OBS	0450	-01 86	34 90	28 12		5 60	4739 9
STD	0500	-01 89	34 90	28 12	0 019	5 68	4742 4
OBS	0500	-01 89	34 90	28 12		5 68	4742 4
OBS	0550	-01 92	34 90	28 12		5 74	4744 9
OBS	0575	-01 89	34 91	28 13		5 75	4746 9

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0020	12	12	1960	00	77° 53' S	166° 44' E	0585	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
03	09			02 0					9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 29	34 75	27 98	0 000	5 94	4721 4
OBS	0000	-01 29	34 75	27 98		5 94	4721 4
OBS	0005	-01 90	34 76	28 01		5 86	4712 1
STD	0010	-01 88	34 77	28 01	0 001	5 89	4712 8
OBS	0010	-01 88	34 77	28 01		5 89	4712 8
STD	0020	-01 90	34 76	28 01	0 002	5 88	4713 0
OBS	0020	-01 90	34 76	28 01		5 88	4713 0
STD	0030	-01 93	34 76	28 01	0 003	5 85	4713 1
OBS	0030	-01 93	34 76	28 01		5 85	4713 1
STD	0050	-01 93	34 77	28 02	0 006	5 80	4714 4
OBS	0050	-01 93	34 77	28 02		5 80	4714 4
STD	0075	-01 92	34 77	28 02	0 008	5 82	4716 0
OBS	0075	-01 92	34 77	28 02		5 82	4716 0
STD	0100	-01 91	34 70	27 96	0 011	5 66	4717 4
OBS	0100	-01 91	34 70	27 96		5 66	4717 4
STD	0150	-01 87	34 77	28 01	0 018	5 78	4721 3
OBS	0150	-01 87	34 77	28 01		5 78	4721 3
STD	0200	-01 87	34 81	28 05	0 022	5 79	4724 4
OBS	0200	-01 87	34 81	28 05		5 79	4724 4
STD	0250	-01 90	34 78	28 02	0 025	5 80	4726 8
OBS	0250	-01 90	34 78	28 02		5 80	4726 8
STD	0300	-01 89	34 78	28 02	0 029	5 80	4729 9
OBS	0300	-01 89	34 78	28 02		5 80	4729 9
OBS	0350	-01 89	34 77	28 01		5 79	4732 9
STD	0400	-01 87	34 79	28 03	0 037	5 80	4736 2
OBS	0400	-01 87	34 79	28 03		5 80	4736 2
OBS	0450	-01 87	34 79	28 03		5 85	4739 2
STD	0500	-01 86	34 78	28 02	0 044	5 84	4742 3
OBS	0500	-01 86	34 78	28 02		5 84	4742 3
OBS	0550	-01 88	34 78	28 02		5 85	4745 0
OBS	0575	-01 89	34 81	28 05		5 84	4746 4

SURFACE OBSERVATIONS									
NODC REF NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0021	12	23	1960	00	77° 53′ S	166° 44′ E	0588	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMID-ITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR	AMT	DIR	AMT.		COL	TRANS.
03	09			55 0			03		9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_t
STD	0000	-01 82	34 48	27 78	0 000	6 58	4711 9
OBS	0000	-01 82	34 48	27 78		6 58	4711 9
OBS	0005	-01 75	34 59	27 86		6 23	4713 8
STD	0010	-01 79	34 63	27 90	0 003	6 30	4713 6
OBS	0010	-01 79	34 63	27 90		6 30	4713 6
STD	0020	-01 80	34 63	27 90	0 005	6 04	4714 1
OBS	0020	-01 80	34 63	27 90		6 04	4714 1
STD	0030	-01 83	34 63	27 90	0 007	6 19	4714 2
OBS	0030	-01 83	34 63	27 90		6 19	4714 2
STD	0050	-01 84	34 67	27 93	0 011	6 01	4715 4
OBS	0050	-01 84	34 67	27 93		6 01	4715 4
STD	0075	-01 88	34 71	27 97	0 015	5 82	4716 4
OBS	0075	-01 88	34 71	27 97		5 82	4716 4
STD	0100	-01 90	34 70	27 96	0 019	5 46	4717 5
OBS	0100	-01 90	34 70	27 96		5 46	4717 5
STD	0150	-01 90	34 74	27 99	0 026	4 89	4720 7
OBS	0150	-01 90	34 74	27 99		4 89	4720 7
STD	0200	-01 90	34 76	28 01	0 031	5 10	4723 7
OBS	0200	-01 90	34 76	28 01		5 10	4723 7
STD	0250	-01 92	34 74	27 99	0 037	5 34	4726 3
OBS	0250	-01 92	34 74	27 99		5 34	4726 3
STD	0300	-01 91	34 77	28 01	0 042	5 34	4729 6
OBS	0300	-01 91	34 77	28 01		5 34	4729 6
OBS	0350	-01 92	34 86	28 09		5 58	4732 8
STD	0400	-01 84	34 85	28 08	0 047	5 38	4737 0
OBS	0400	-01 84	34 85	28 08		5 38	4737 0
OBS	0450	-01 88	34 90	28 12		5 62	4739 5
STD	0500	-01 89	34 88	28 10	0 048	5 35	4742 3
OBS	0500	-01 89	34 88	28 10		5 35	4742 3
OBS	0550	-01 91	34 91	28 13		5 76	4745 1
OBS	0575	-01 86	34 93	28 14		5 58	4747 4

SURFACE OBSERVATIONS

NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0022	01	04	1961	01	77° 53′ S	166° 44′ E	0588	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT	DIR.	AMT.		COL.	TRANS
00	00			51 9			03		7							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	Σ ΔD	O_2 ml/l	V_f
STD	0000	-01 43	34 63	27 89	0 000	6 82	4718 7
OBS	0000	-01 43	34 63	27 89		6 82	4718 7
OBS	0005	-01 73	34 71	27 96		6 45	4714 6
STD	0010	-01 73	34 72	27 97	0 002	6 42	4715 0
OBS	0010	-01 73	34 72	27 97		6 42	4715 0
STD	0020	-01 76	34 72	27 97	0 003	6 36	4715 1
OBS	0020	-01 76	34 72	27 97		6 36	4715 1
STD	0030	-01 77	34 76	28 00	0 005	6 36	4715 7
OBS	0030	-01 77	34 76	28 00		6 36	4715 7
STD	0050	-01 79	34 74	27 99	0 007	6 19	4716 5
OBS	0050	-01 79	34 74	27 99		6 19	4716 5
STD	0075	-01 80	34 75	28 00	0 010	6 18	4717 8
OBS	0075	-01 80	34 75	28 00		6 18	4717 8
STD	0100	-01 80	34 76	28 00	0 013	6 20	4719 4
OBS	0100	-01 80	34 76	28 00		6 20	4719 4
STD	0150	-01 81	34 78	28 02	0 018	6 12	4722 3
OBS	0150	-01 81				6 12	
STD	0200	-01 84	34 80	28 04	0 022	5 93	4724 9
OBS	0200	-01 84	34 80	28 04		5 93	4724 9
STD	0250	-01 88	34 82	28 05	0 025	5 88	4727 3
OBS	0250	-01 88	34 82	28 05		5 88	4727 3
STD	0300	-01 88	34 86	28 09	0 027	5 87	4730 4
OBS	0300	-01 88	34 86	28 09		5 87	4730 4
OBS	0350	-01 88	34 86	28 09		5 82	4733 4
STD	0400	-01 88	34 87	28 10	0 029	5 77	4736 4
OBS	0400	-01 88	34 87	28 10		5 77	4736 4
OBS	0450	-01 87	34 87	28 09		5 86	4739 6
STD	0500	-01 89	34 88	28 10	0 029	5 89	4742 3
OBS	0500	-01 89	34 88	28 10		5 89	4742 3
OBS	0550	-01 90	34 88	28 10		5 95	4745 1
OBS	0575	-01 88	34 89	28 11		5 94	4746 9

SURFACE OBSERVATIONS								
NODC REF. NO	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0023	01	10	1961	24	77° 53′S	166° 44′E	0588	06

WIND		ANEMO HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR	AMT	DIR.	AMT.		COL.	TRANS.
00	00			01 7			00		0							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 51	34 03	27 40	0 000	8 19	4714 8
OBS	0000	-01 51	34 03	27 40		8 19	4714 8
OBS	0005	-01 42	34 15	27 50		7 90	4717 1
STD	0010	-01 43	34 22	27 56	0 006	7 95	4717 5
OBS	0010	-01 43	34 22	27 56		7 95	4717 5
STD	0020	-01 53	34 33	27 65	0 011	7 56	4717 0
OBS	0020	-01 53	34 33	27 65		7 56	4717 0
STD	0030	-01 65	34 51	27 80	0 015	7 02	4716 5
OBS	0030	-01 65	34 51	27 80		7 02	4716 5
STD	0050	-01 61	34 53	27 81	0 021	6 95	4718 4
OBS	0050	-01 61	34 53	27 81		6 95	4718 4
STD	0075	-01 76	34 64	27 91	0 027	6 54	4718 0
OBS	0075	-01 76	34 64	27 91		6 54	4718 0
STD	0100	-01 81	34 71	27 96	0 032	6 09	4719 0
OBS	0100	-01 81	34 71	27 96		6 09	4719 0
STD	0150	-01 86	34 78	28 02	0 038	5 78	4721 5
OBS	0150	-01 86	34 78	28 02		5 78	4721 5
STD	0200	-01 89	34 81	28 05	0 041	5 68	4724 1
OBS	0200	-01 89	34 81	28 05		5 68	4724 1
STD	0250	-01 92	34 82	28 06	0 044	5 73	4726 7
OBS	0250	-01 92	34 82	28 06		5 73	4726 7
STD	0300	-01 88	34 83	28 06	0 047	5 75	4730 3
OBS	0300	-01 88	34 83	28 06		5 75	4730 3
OBS	0350	-01 90	34 88*	28 10*		5 72	4733 2*
STD	0400	-01 89	34 83	28 06	0 051	5 70	4736 1
OBS	0400	-01 89	34 83	28 06		5 70	4736 1
OBS	0450	-01 87	34 86	28 09		5 76	4739 5
STD	0500	-01 88	34 88	28 10	0 052	5 76	4742 4
OBS	0500	-01 88	34 88	28 10		5 76	4742 4
OBS	0550	-01 89	34 86	28 09		5 78	4745 2
OBS	0575	-01 87	34 87	28 09		5 76	4747 0

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0024	01	19	1961	23	77° 53′ S	166° 44′ E	0578	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR	AMT.		COL.	TRANS.
03	27			51 0	51 7	89	70		9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S‰	σ_t	$\Sigma\Delta D$	O_2 ml/l	V_f
STD	0000	-01 78	34 18	27 53	0 000	7 67	4711 2
OBS	0000	-01 78	34 18	27 53		7 67	4711 2
OBS	0005	-01 71	34 26	27 60		7 43	4713 0
STD	0010	-01 72	34 28	27 61	0 005	7 48	4713 2
OBS	0010	-01 72	34 28	27 61		7 48	4713 2
STD	0020	-01 77	34 31	27 64	0 010	7 26	4713 1
OBS	0020	-01 77	34 31	27 64		7 26	4713 1
STD	0030	-01 78	34 33	27 65	0 014	7 30	4713 7
OBS	0030	-01 78	34 33	27 65		7 30	4713 7
STD	0050	-01 84	34 71	27 96	0 020	6 37	4715 6
OBS	0050	-01 84	34 71	27 96		6 37	4715 6
STD	0075	-01 87	34 71	27 97	0 024	6 23	4716 6
OBS	0075	-01 87	34 71	27 97		6 23	4716 6
STD	0100	-01 85	34 71	27 96	0 028	6 21	4718 4
OBS	0100	-01 85	34 71	27 96		6 21	4718 4
STD	0150	-01 87	34 79	28 03	0 034	5 85	4721 4
OBS	0150	-01 87	34 79	28 03		5 85	4721 4
STD	0200	-01 89	34 79	28 03	0 038	5 84	4724 0
OBS	0200	-01 89	34 79	28 03		5 84	4724 0
STD	0250	-01 91	34 81	28 05	0 041	5 85	4726 8
OBS	0250	-01 91	34 81	28 05		5 85	4726 8
STD	0300	-01 88	34 81	28 05	0 044	5 84	4730 2
OBS	0300	-01 88	34 81	28 05		5 84	4730 2
OBS	0350	-01 89	34 86	28 09		5 76	4733 3
STD	0400	-01 87	34 86	28 09	0 048	5 72	4736 5
OBS	0400	-01 87	34 86	28 09		5 72	4736 5
OBS	0450	-01 86	34 86	28 09		5 79	4739 7
STD	0500	-01 89	34 87	28 10	0 049	5 79	4742 2
OBS	0500	-01 89	34 87	28 10		5 79	4742 2
OBS	0550	-01 91	34 88	28 10		5 88	4744 9
OBS	0575	-01 88	34 89	28 11		5 94	4746 9

SURFACE OBSERVATIONS

NODC REF NO	STATION	DATE MO	DATE DAY	DATE YEAR	DATE HOUR	POSITION LATITUDE	POSITION LONGITUDE	SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
00598	0025	02	01	1961	24	77° 53 S	166 44 E	0577	06

WIND SPEED	WIND DIR	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMIDITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR	SEA AMT	SWELL DIR	SWELL AMT	VIS.	WATER COL	WATER TRANS
03	09			00 0			03		9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma\Delta D$	O_2 ml/l	V_f
STD	0000	-01 83	34 21	27 56	0 000	7 24	4710 6
OBS	0000	-01 83	34 21	27 56		7 24	4710 6
OBS	0005	-01 83	34 26	27 60		7 24	4711 1
STD	0010	-01 78	34 27	27 61	0 005	7 12	4712 2
OBS	0010	-01 78	34 27	27 61		7 12	4712 2
STD	0020	-01 76	34 33	27 65	0 010	7 07	4713 4
OBS	0020	-01 76	34 33	27 65		7 07	4713 4
STD	0030	-01 73	34 35	27 67	0 014	6 96	4714 5
OBS	0030	-01 73	34 35	27 67		6 96	4714 5
STD	0050	-01 65	34 51	27 80	0 022	6 70	4717 7
OBS	0050	-01 65	34 51	27 80		6 70	4717 7
STD	0075	-01 75	34 60	27 87	0 028	6 28	4718 0
OBS	0075	-01 75	34 60	27 87		6 28	4718 0
STD	0100	-01 75	34 65	27 91	0 034	6 10	4719 7
OBS	0100	-01 75	34 65	27 91		6 10	4719 7
STD	0150	-01 86	34 79	28 03	0 041	5 76	4721 5
OBS	0150	-01 86	34 79	28 03		5 76	4721 5
STD	0200	-01 90	34 84	28 07	0 044	5 72	4724 1
OBS	0200	-01 90	34 84	28 07		5 72	4724 1
STD	0250	-01 91	34 78	28 02	0 047	5 74	4726 6
OBS	0250	-01 91	34 78	28 02		5 74	4726 6
STD	0300	-01 89	34 80	28 04	0 051	5 71	4730 0
OBS	0300	-01 89	34 80	28 04		5 71	4730 0
OBS	0350	-01 90	34 80	28 04		5 66	4732 8
STD	0400	-01 88	34 81	28 05	0 057	5 70	4736 2
OBS	0400	-01 88	34 81	28 05		5 70	4736 2
OBS	0450	-01 86	34 87	28 09		5 68	4739 7
STD	0500	-01 89	34 88	28 10	0 059	5 78	4742 3
OBS	0500	-01 89	34 88	28 10		5 78	4742 3
OBS	0550	-01 91	34 88	28 10		5 82	4744 9
OBS	0570	-01 87	34 90	28 12		5 78	4746 8

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE: MO.	DATE: DAY	DATE: YEAR	DATE: HOUR	POSITION: LATITUDE	POSITION: LONGITUDE	SONIC DEPTH UNCORRECTED	MAX SAMPLE DEPTH
00598	0026	02	09	1961	24	77° 53' S	166° 44' E	0576	06

WIND SPEED	WIND DIR	ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE DRY	AIR TEMPERATURE WET	HUMID-ITY	WEATHER	CLOUD TYPE	CLOUD AMT.	SEA DIR.	SEA AMT.	SWELL DIR.	SWELL AMT.	VIS.	WATER COL.	WATER TRANS
05	14			58 0			03		9							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 70	34 03	27 41	0 000	7 54	4711 8
OBS	0000	-01 70	34 03	27 41		7 54	4711 8
OBS	0005	-01 80	34 03	27 41		7 53	4710 6
STD	0010	-01 78	34 08	27 45	0 007	7 43	4711 4
OBS	0010	-01 78	34 08	27 45		7 43	4711 4
STD	0020	-01 74	34 15	27 51	0 013	7 40	4712 9
OBS	0020	-01 74	34 15	27 51		7 40	4712 9
STD	0030	-01 76	34 21	27 56	0 018	7 27	4713 5
OBS	0030	-01 76	34 21	27 56		7 27	4713 5
STD	0050	-01 63	34 34	27 66	0 028	7 14	4717 3
OBS	0050	-01 63	34 34	27 66			4717 3
STD	0075	-01 54	34 43	27 73	0 038	6 96	4720 6
OBS	0075	-01 54	34 43	27 73		6 96	4720 6
STD	0100	-01 46	34 50	27 78	0 047	6 77	4723 6
OBS	0100	-01 46	34 50	27 78		6 77	4723 6
STD	0150	-01 81	34 64	27 91	0 060	6 16	4721 7
OBS	0150	-01 81	34 64	27 91		6 16	4721 7
STD	0200	-01 88	34 74	27 99	0 068	5 85	4724 0
OBS	0200	-01 88	34 74	27 99		5 85	4724 0
STD	0250	-01 91	34 76	28 01	0 073	5 80	4726 5
OBS	0250	-01 91	34 76	28 01		5 80	4726 5
STD	0300	-01 88	34 78	28 02	0 078	5 82	4730 1
OBS	0300	-01 88	34 78	28 02		5 82	4730 1
OBS	0350	-01 89	34 81	28 05		5 70	4733 0
STD	0400	-01 88	34 81	28 05	0 084	5 78	4736 2
OBS	0400	-01 88	34 81	28 05		5 78	4736 2
OBS	0450	-01 86	34 83	28 06		5 80	4739 6
STD	0500	-01 88	34 85	28 08	0 088	5 78	4742 3
OBS	0500	-01 88	34 85	28 08		5 78	4742 3
OBS	0550	-01 90	34 88	28 10		5 84	4745 1
OBS	0570	-01 86	34 96	28 17		5 86	4747 3

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0027	02	21	1961	02	77° 53 S	166 44 E	0576	06

WIND		ANEMO HGT	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS	WATER	
SPEED	DIR			DRY	WET			TYPE	AMT.	DIR	AMT	DIR	AMT		COL.	TRANS
00	00			68 5			00		0							

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 58	34 01	27 39	0 000	7 28	4713 7
OBS	0000	-01 58	34 01	27 39		7 29	4713 7
OBS	0005	-01 84	34 04	27 42		7 32	4710 0
STD	0010	-01 84	34 00	27 39	0 007	7 28	4710 1
OBS	0010	-01 84	34 00	27 39		7 28	4710 1
STD	0020	-01 85	34 00	27 39	0 014	7 27	4710 5
OBS	0020	-01 85	34 00	27 39		7 27	4710 5
STD	0030	-01 86	34 03	27 41	0 021	7 24	4711 1
OBS	0030	-01 86	34 03	27 41		7 24	4711 1
STD	0050	-01 92	34 33	27 66	0 032	7 03	4712 6
OBS	0050	-01 92	34 33	27 66		7 03	4712 6
STD	0075	-01 37	34 41	27 71	0 042	6 81	4723 2
OBS	0075	-01 37	34 41	27 71		6 81	4723 2
STD	0100	-01 40	34 52	27 80	0 051	6 54	4724 7
OBS	0100	-01 40	34 52	27 80		6 54	4724 7
STD	0150	-01 52	34 63	27 89	0 064	6 08	4726 2
OBS	0150	-01 52	34 63	27 89		6 08	4726 2
STD	0200	-01 74	34 67	27 93	0 074	5 87	4725 9
OBS	0200	-01 74	34 67	27 93		5 87	4725 9
STD	0250	-01 82	34 70	27 96	0 082	5 81	4727 7
OBS	0250	-01 82	34 70	27 96		5 81	4727 7
STD	0300	-01 86	34 75	28 00	0 088	5 66	4730 3
OBS	0300	-01 86	34 75	28 00		5 66	4730 3
OBS	0350	-01 86	34 76	28 01		5 70	4733 3
STD	0400	-01 85	34 79	28 03	0 097	5 71	4736 6
OBS	0400	-01 85	34 79	28 03		5 71	4736 6
OBS	0450	-01 85	34 77	28 01		5 72	4739 4
STD	0500	-01 88	34 86	28 09	0 101	5 66	4742 3
OBS	0500	-01 88	34 86	28 09		5 66	4742 3
OBS	0550	-01 89	34 82	28 05		5 68	4745 0
OBS	0570	-01 86	34 83	28 06		5 70	4746 7

SURFACE OBSERVATIONS									
NODC REF. NO.	STATION	DATE				POSITION		SONIC DEPTH UNCORRECTED	MAX. SAMPLE DEPTH
		MO.	DAY	YEAR	HOUR	LATITUDE	LONGITUDE		
00598	0028	03	08	1961	00	77° 53′ S	166° 44′ E	0582	06

WIND		ANEMO. HGT.	AIR PRESS	AIR TEMPERATURE		HUMIDITY	WEATHER	CLOUD		SEA		SWELL		VIS.	WATER	
SPEED	DIR.			DRY	WET			TYPE	AMT.	DIR.	AMT.	DIR.	AMT.		COL.	TRANS.
02				59 0					4					9		

SUBSURFACE OBSERVATIONS

	SAMPLE DEPTH (M)	T °C	S ‰	σ_t	$\Sigma \Delta D$	O_2 ml/l	V_f
STD	0000	-01 80	34 04	27 42	0 000	8 33	4710 3
OBS	0000	-01 80	34 04	27 42		8 33	4710 3
OBS	0005	-01 83	34 05	27 43		8 32	4710 2
STD	0010	-01 82	34 09	27 46	0 006	8 38	4710 8
OBS	0010	-01 82	34 09	27 46		8 38	4710 8
STD	0020	-01 82	34 07	27 44	0 013	8 40	4711 3
OBS	0020	-01 82	34 07	27 44		8 40	4711 3
STD	0030	-01 82	34 05	27 43	0 019	8 20	4711 8
OBS	0030	-01 82	34 05	27 43		8 20	4711 8
STD	0050	-01 71	34 20	27 55	0 031	8 26	4715 4
OBS	0050	-01 71	34 20	27 55		8 26	4715 4
STD	0075	-01 68	34 27	27 60	0 044	8 02	4717 7
OBS	0075	-01 68	34 27	27 60		8 02	4717 7
STD	0100	-01 49	34 38	27 69	0 056	7 76	4722 6
OBS	0100	-01 49	34 38	27 69		7 76	4722 6
STD	0150	-01 52	34 45	27 74	0 075	7 30	4725 4
OBS	0150	-01 52	34 45	27 74		7 30	4725 4
STD	0200	-01 72	34 47	27 77	0 092	6 81	4725 3
OBS	0200	-01 72	34 47	27 77		6 81	4725 3
STD	0250	-01 85	34 54	27 83	0 107	6 67	4726 5
OBS	0250	-01 85	34 54	27 83		6 67	4726 5
STD	0300	-01 87	34 56	27 84	0 120	6 70	4729 3
OBS	0300	-01 87	34 56	27 84		6 70	4729 3
OBS	0350	-01 85	34 58	27 86		6 64	4732 7
STD	0400	-01 86	34 58	27 86	0 144	6 61	4735 5
OBS	0400	-01 86	34 58	27 86		6 61	4735 5
OBS	0450	-01 86	34 58	27 86		6 68	4738 5
STD	0500	-01 90	34 69	27 95	0 162	6 72	4741 3
OBS	0500	-01 90	34 69	27 95		6 72	4741 3
OBS	0550	-01 90	34 72	27 97		6 73	4744 4
OBS	0570	-01 88	34 72	27 97		6 71	4745 9

APPENDIX B

SEDIMENT ANALYSIS SUMMARY SHEETS

EXPLANATION OF SEDIMENT ANALYSIS SUMMARY SHEET
(OCEANOGRAPHIC LOG SHEET-R)

Results of bottom sediment sample analysis performed by the U. S. Navy Hydrographic Office are recorded on the sediment analysis summary sheets. Almost all bottom samples are analyzed weeks after the collection of the samples; therefore, various procedures normally carried out during a routine sediment analysis are not attempted. Determinations such as: wet density, water content, porosity, etc., are not possible after the samples have lost their "in situ" moisture; therefore, all values left blank on the summary sheets indicate these values could not be accurately determined.

The following is a description of the terms employed on the sediment analysis summary sheets:

1. Cruise Number. This number is arbitrarily assigned. It identified the cruise and provides a means of sorting from the IBM files all cards pertaining to that particular cruise.

2. Sample Number. A consecutive number, commencing with 1, applied to each bottom grab sample or core taken successively throughout the cruise.

3. Sampler Type. Identified by name of device employed.

4. Latitude. Expressed in degrees, minutes, and seconds.

5. Longitude. Expressed in degrees, minutes, and seconds.

6. Date. Day (GMT), month, and year.

7. Water Depth (m). The uncorrected sonic sounding recorded to the nearest hundredth of a meter.

8. Core Length (cm). Recorded to the nearest tenth of a centimeter as observed in the laboratory. This information is not given when a grab sampler is employed.

9. Core Penetration (cm). Recorded to the nearest centimeter as observed in the field. This information is not given when a grab sampler is employed.

10. Laboratory Number. A reference number assigned to a fraction of a sample retained by the Laboratory.

11. Subsample Depth in Core (cm). Depth to the nearest tenth of a centimeter of the mean depth of the subsample. This information was not entered when a surface grab sample or a short core sample was obtained; for the latter the analysis of the subsample is assumed as representative of the entire core length.

12. Color. Based on the Geological Society of America Rock-Color Chart. For those samples where color was not determined in the field, the sample was moistened in the laboratory for a color determination.

13. Odor. A field description. A qualitative description of any noticeable odors.

14. Size Analysis and Statistical Measures. The following table is presented for the conversion of phi units to millimeters:

$-\phi = \log_2$ diameter (millimeters)

Phi (ϕ)	Millimeters	Geological Classification
-2	4.0	
-1	2.0	Granule
0	1.0	
1	0.50	
2	0.25	
3	0.125	
4	0.0625	Sand
5	0.0313	
6	0.0156	
7	0.0078	
8	0.0039	
9	0.00195	Silt
>9	-------	Clay

Sample size fraction values are based on dry weight and given in phi (ϕ) units to the nearest whole percent. An American instrument company sieving machine and U. S. standard sieves along with the pipette method, based on Stoke's Law (for computing settling rates of spherical particles), were used for determining:

(a) % Coarser Than Sand (L-1ϕ). The fraction less than -1ϕ.

(b) % Sand. The fraction greater than $+4\phi$.

(c) % Silt. The fraction from 4ϕ to 9ϕ.

(d) % Clay. The fraction greater than 9ϕ.

(e) Sediment Type. Determined by the sand, silt, and clay ratios of the sample based on the F. D. Shepard sediment triangle in the "Journal of Sedimentary Petrology," Vol. 24, no. 3, pp. 151-158, 1954.

(f) Phi Median Diameter (Mdϕ). The middlemost member of the distribution curve above which 50 percent of the diameters in the distribution are large and below which 50 percent of the diameters in the distribution are smaller and is expressed to the nearest hundredth of a phi unit. The given value computed by the formula:

$$Md\phi = \frac{\phi 84 + \phi 16}{2}$$

(g) Phi Deviation Measure ($\sigma\phi$). A measure of one half of the spread of the quartiles and is expressed in phi units to the nearest hundreth with the given value computed from the formula:

$$\sigma\phi = \frac{\phi 84 - \phi 16}{2}$$

(h) Phi Skewness Measure (a_ϕ). A measure of the symmetry of the curve in such a way that the departure of the mean from the median is independent of the spread or deviation of the curve. It is expressed in phi units to the nearest hundredth with the given value computed from the formula:

$$a_\phi = \frac{M_\phi - Md_\phi}{\sigma\phi}$$

where $M\phi$ (mean) is equal to half the sum of the quartiles.

OCEANOGRAPHIC LOG SHEET-R
PRNC-NHO-3167/18 (Rev. 4-60)

SEDIMENT ANALYSIS SUMMARY SHEET

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	2
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	10 May 1960
7. WATER DEPTH (meters)	570
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6950
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) [F] FIELD [L] LAB. DETERMINATION	F Light Olive Gray 5Y5/2
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	40
b. % SAND	51
c. % SILT / d. % CLAY	8
e. SEDIMENT TYPE	Pebbly Sand
f. PHI MEDIAN DIAMETER (Md φ)	-1.29
g. PHI DEVIATION MEASURE (σ φ)	2.53
h. PHI SKEWNESS MEASURE (α φ)	0.25

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	8
3. SAMPLER TYPE	Orange Peel
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	18 July 1960
7. WATER DEPTH (meters)	566
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6952
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) [F] FIELD [L] LAB. DETERMINATION	L Olive Gray 5Y4/1
13. ODOR (earthy, moldy, rank, H_2S, etc.)	
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	49
b. % SAND	49
c. % SILT / d. % CLAY	3
e. SEDIMENT TYPE	Sand & Pebbles
f. PHI MEDIAN DIAMETER (Md φ)	-0.90
g. PHI DEVIATION MEASURE (σ φ)	
h. PHI SKEWNESS MEASURE (α φ)	

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	4
3. SAMPLER TYPE	Orange Peel
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	13 June 1960
7. WATER DEPTH (meters)	566
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6951
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) [F] FIELD [L] LAB. DETERMINATION	L Dusky Brown 5YR 2/2
13. ODOR (earthy, moldy, rank, H_2S, etc.)	
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	23
b. % SAND	76
c. % SILT / d. % CLAY	Trace
e. SEDIMENT TYPE	Pebbly Sand
f. PHI MEDIAN DIAMETER (Md φ)	-0.16
g. PHI DEVIATION MEASURE (σ φ)	1.31
h. PHI SKEWNESS MEASURE (α φ)	+0.06

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	9
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	20 July 1960
7. WATER DEPTH (meters)	566
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6953
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) [F] FIELD [L] LAB. DETERMINATION	F Moderate Olive Brown 5Y4/4
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	57
b. % SAND	41
c. % SILT / d. % CLAY	2
e. SEDIMENT TYPE	Pebbles w/Sand
f. PHI MEDIAN DIAMETER (Md φ)	-0.76
g. PHI DEVIATION MEASURE (σ φ)	2.33
h. PHI SKEWNESS MEASURE (α φ)	-0.23

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 10	3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53' S	7. WATER DEPTH (meters) 566	
5. LONGITUDE 166° 44' E	8. CORE LENGTH (cm)	
6. DATE (day, month, year) 22 July 1960	9. CORE PENETRATION (cm)	

10. LABORATORY NUMBER	6954			
11. SUB SAMPLE DEPTH IN CORE (cm)				
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	Grayish Olive 10Y4/2 F			
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND (<−1 φ)	50			
b. % SAND	48			
c. % SILT	} 3			
d. % CLAY				
e. SEDIMENT TYPE	Pebbles w/ Sand			
f. PHI MEDIAN DIAMETER (Md φ)	−1.00			
g. PHI DEVIATION MEASURE (σ φ)				
h. PHI SKEWNESS MEASURE (α φ)				

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 12	3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53' S	7. WATER DEPTH (meters) 566	
5. LONGITUDE 166 44' E	8. CORE LENGTH (cm)	
6. DATE (day, month, year) 27 July 1960	9. CORE PENETRATION (cm)	

10. LABORATORY NUMBER	6956			
11. SUB SAMPLE DEPTH IN CORE (cm)				
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	Grayish Olive 10Y4/2 F			
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND (<−1 φ)	66			
b. % SAND	31			
c. % SILT	} 3			
d. % CLAY				
e. SEDIMENT TYPE	Pebbles w/ Sand			
f. PHI MEDIAN DIAMETER (Md φ)	−3.10			
g. PHI DEVIATION MEASURE (σ φ)	0.18			
h. PHI SKEWNESS MEASURE (α φ)	2.60			

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 11	3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53' S	7. WATER DEPTH (meters) 566	
5. LONGITUDE 166° 44' E	8. CORE LENGTH (cm)	
6. DATE (day, month, year) 25 July 1960	9. CORE PENETRATION (cm)	

10. LABORATORY NUMBER	6955			
11. SUB SAMPLE DEPTH IN CORE (cm)				
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	Grayish Olive 10Y4/2 F			
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND (<−1 φ)	26			
b. % SAND	62			
c. % SILT	} 11			
d. % CLAY				
e. SEDIMENT TYPE	Pebbly Sand			
f. PHI MEDIAN DIAMETER (Md φ)	1.00			
g. PHI DEVIATION MEASURE (σ φ)				
h. PHI SKEWNESS MEASURE (α φ)				

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 14	3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53' S	7. WATER DEPTH (meters) 566	
5. LONGITUDE 166 44' E	8. CORE LENGTH (cm)	
6. DATE (day, month, year) 9 September 1960	9. CORE PENETRATION (cm)	

10. LABORATORY NUMBER	6957			
11. SUB SAMPLE DEPTH IN CORE (cm)				
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	Moderate Olive Brown 5Y4/4 F			
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND (<−1 φ)	54			
b. % SAND	41			
c. % SILT	} 4			
d. % CLAY				
e. SEDIMENT TYPE	Pebbles w/ Sand			
f. PHI MEDIAN DIAMETER (Md φ)	−1.28			
g. PHI DEVIATION MEASURE (σ φ)				
h. PHI SKEWNESS MEASURE (α φ)				

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	16
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	12 October 1960
7. WATER DEPTH (meters)	578
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6958
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	F Moderate Olive Brown 5Y4/4
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	62
b. % SAND	34
c. % SILT	4
d. % CLAY	
e. SEDIMENT TYPE	Pebbles w/Sand
f. PHI MEDIAN DIAMETER (Md φ)	−1.81
g. PHI DEVIATION MEASURE (σ φ)	2.72
h. PHI SKEWNESS MEASURE (α φ)	−0.27

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	17
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	23 October 1960
7. WATER DEPTH (meters)	580
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6959
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	F Moderate Olive Brown 5Y4/4
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	21
b. % SAND	74
c. % SILT	5
d. % CLAY	
e. SEDIMENT TYPE	Pebbly Sand
f. PHI MEDIAN DIAMETER (Md φ)	0.38
g. PHI DEVIATION MEASURE (σ φ)	1.65
h. PHI SKEWNESS MEASURE (α φ)	−0.02

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	18
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	29 November 1960
7. WATER DEPTH (meters)	585
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6960
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	F Grayish Olive 10Y4/2
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	41
b. % SAND	56
c. % SILT	3
d. % CLAY	
e. SEDIMENT TYPE	Pebbly Sand
f. PHI MEDIAN DIAMETER (Md φ)	−0.18
g. PHI DEVIATION MEASURE (σ φ)	2.62
h. PHI SKEWNESS MEASURE (α φ)	0.34

1. CRUISE NO.	MCMURDO SOUND
2. SAMPLE NO.	19
3. SAMPLER TYPE	Peterson Grab
4. LATITUDE	77° 53' S
5. LONGITUDE	166° 44' E
6. DATE (day, month, year)	3 December 1960
7. WATER DEPTH (meters)	581
8. CORE LENGTH (cm)	
9. CORE PENETRATION (cm)	
10. LABORATORY NUMBER	6961
11. SUB SAMPLE DEPTH IN CORE (cm)	
12. COLOR (by the GSA rock color chart) F FIELD L LAB. DETERMINATION	F Moderate Olive Brown 5Y4/4
13. ODOR (earthy, moldy, rank, H_2S, etc.)	F None
14. SIZE ANALYSIS and STATISTICAL MEASURES	
a. % COARSER THAN SAND (<−1 φ)	
b. % SAND	
c. % SILT	
d. % CLAY	
e. SEDIMENT TYPE	
f. PHI MEDIAN DIAMETER (Md φ)	
g. PHI DEVIATION MEASURE (σ φ)	
h. PHI SKEWNESS MEASURE (α φ)	

The sample was composed of sponge spicules with some coarse sand and shell fragments; insufficient sample for analysis.

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 20		3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53′ ″ S		7. WATER DEPTH *(meters)* 585	
5. LONGITUDE 166° 44′ ″ E		8. CORE LENGTH *(cm)*	
6. DATE *(day, month, year)* 23 December 1960		9. CORE PENETRATION *(cm)*	

10. LABORATORY NUMBER	6962			
11. SUB SAMPLE DEPTH IN CORE *(cm)*				
12. COLOR *(by the GSA rock color chart)* F FIELD L LAB. DETERMINATION	F Grayish Olive 10 Y4/2			
13. ODOR *(earthy, moldy, rank, H_2S, etc.)*	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND ($<-1\ \phi$)	66			
b. % SAND	30			
c. % SILT				
d. % CLAY	3			
e. SEDIMENT TYPE	Pebbles w/ Sand			
f. PHI MEDIAN DIAMETER ($Md\ \phi$)	-2.67			
g. PHI DEVIATION MEASURE ($\sigma\ \phi$)				
h. PHI SKEWNESS MEASURE ($\alpha\ \phi$)				

1. CRUISE NO. MCMURDO SOUND	2. SAMPLE NO. 21		3. SAMPLER TYPE Peterson Grab
4. LATITUDE 77° 53′ ″ S		7. WATER DEPTH *(meters)* 588	
5. LONGITUDE 166° 44′ ″ E		8. CORE LENGTH *(cm)*	
6. DATE *(day, month, year)* 29 December 1960		9. CORE PENETRATION *(cm)*	

10. LABORATORY NUMBER	6963			
11. SUB SAMPLE DEPTH IN CORE *(cm)*				
12. COLOR *(by the GSA rock color chart)* F FIELD L LAB. DETERMINATION	F Moderate Olive Brown 5Y4/4			
13. ODOR *(earthy, moldy, rank, H_2S, etc.)*	F None			
14. SIZE ANALYSIS and STATISTICAL MEASURES				
a. % COARSER THAN SAND ($<-1\ \phi$)	62			
b. % SAND	37			
c. % SILT				
d. % CLAY	2			
e. SEDIMENT TYPE	Pebbles w/ Sand			
f. PHI MEDIAN DIAMETER ($Md\ \phi$)	-2.17			
g. PHI DEVIATION MEASURE ($\sigma\ \phi$)				
h. PHI SKEWNESS MEASURE ($\alpha\ \phi$)				

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2. Oceanography - Antarctic
3. Bottom Sediment - McMurdo Sound

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ii. Authors: Willis L. Tressler and Audun M. Ommundsen

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